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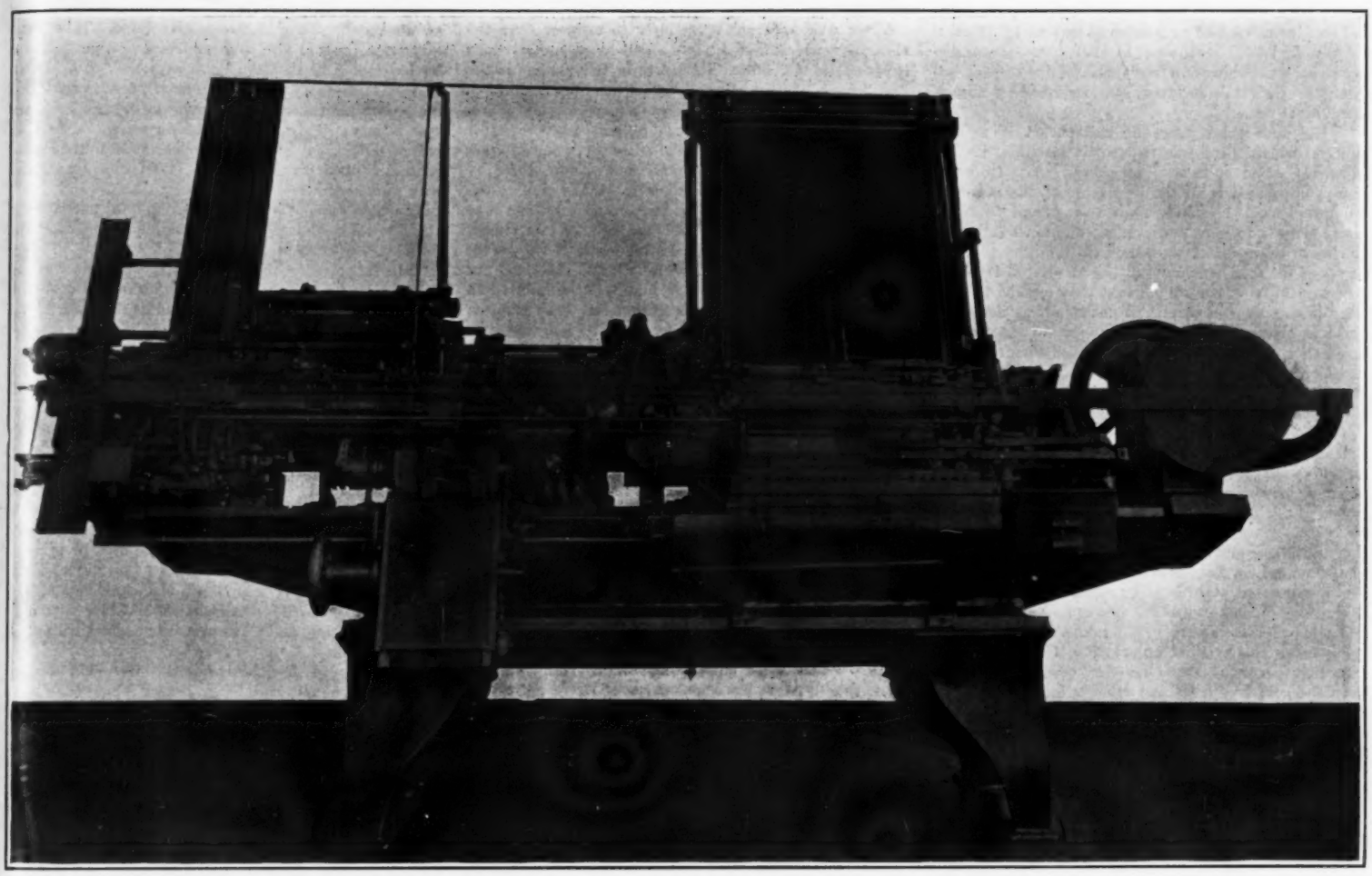

The Paige compositor. A most remarkable example of mechanical ingenuity, which set, justified and distributed type all at the same time. Entire words could be set by a single stroke.

Modern Methods of Composing Type

An Important Step in the Production of Printed Matter

In articles dealing with the advances made in the art of printing, and the making of books, it is customary to dwell on the wonderful improvements of the printing press, and inferentially, to attribute the facility and the cheapness with which printed matter is produced entirely to this cause. As a matter of fact the printing press, perfect and efficient though it is, plays rather a subordinate part in the work of disseminating information and making it so easily attainable by all, for in the cost of making a book the press work is comparatively a minor item.

In the development of the printing press the fundamental idea has apparently been to increase its speed of production, and, although this is a valuable feature, and one that may be considered indispensable in newspaper work, this speed would be of little avail without an equally rapid means for providing the type forms necessary for the operation of the press. From this it will be appreciated that the composition, or setting the type, is fully as important as the printing press as regards economy of time, and in the matter of economy of money the composition takes the leading place, as it involves the greater portion of the labor of producing a book or newspaper.

It is therefore to the improvements in composition that the cheapening of books, and the rapid production of printed matter is mainly due, rather than to the press; and, although not as sensational nor as impressive to look at as the monster newspaper press of the present day, the devices for composing type are by far more ingenious and intricate in their operations.

For four hundred years after the invention of movable type all composition was done by hand, and every individual character, whether letter, figure or punctuation, and the spaces as well, were patiently assembled one at a time to form the printed line, and these lines arranged into columns and pages. The endless infinity of this process is but little realized by those whose eyes skim rapidly over the printed page, but has long been appreciated by all who have had to do intimately with the printing arts, especially as every one of this multitude of pieces must be handled individually twice, first in setting, and again to distribute the type for further use after printing. With such a heavy burden it is a wonder that printing made such progress, and it is also not at all remarkable that inventors have for many years studied various means to do away with hand type setting, both for the economy of time and expense, but also to eliminate the drudgery of the work, and a great many machines have been designed for accomplishing this purpose in various different ways.

It may here be noted that American inventors were apparently the first to produce a machine for setting type, and that every style of machine in practical operation (and they are used all over the world) is of American invention. The first operative composing machine of which we have any record was patented by Dr. William Church of Boston in 1822, and was designed for setting type. The type was contained in inclined channels and these were liberated successively by the operation of keys in a keyboard that somewhat resembled the keyboard of a modern typewriter. As a type emerged from its channel it fell upon a horizontal plate, along which it was swept by arms, operated by clockwork, to a central collecting tube, where the types were assembled in their proper order, and from which they were removed and justified into lines. Although crude, in view of the machines of to-day, the Church device was practical and was used to some extent.

Since Church's time a great number of patents have been taken out, operating on various principles. Broadly stated, composing machines may be divided into four classes as follows:

Type setting machines (some of which also justify).
Type casting and setting machines (Monotype class).
Slug casting machines (the Linotype).
Impression machines.

TYPESETTING MACHINES

Of the type setting machines a great number have been produced, but none have been used much practically, except the Thorn (1880) and the Simplex, which was a modification of the Thorn; and the McMillan, which has been used to some extent. The Thorn machine has two large cylinders, placed vertically one above the other, which have vertical grooves cut in their faces to hold the type. The upper cylinder is the distributer, and its grooves are filled with the lines of used matter. As this cylinder revolves, the type drops out of its grooves into those of the lower, or composing cylinder, the selective distribution being effected by nicks in the type that correspond with fins, or wards, of the grooves of the lower cylinder, so that each character drops into its appropriate channel. The composition was performed by a keyboard, and the depression of a key liberated a single type of the desired character, which, dropping

(Continued on page 324.)

Contact Electrification and the Electric Current*

Historical Notes and Comments on the Various Theories

By Professor Fernando Sanford, Stanford University

In a previous paper in this journal, entitled "The Discovery of Contact Electrification" (November, 1913), it was shown that the production of electric charges by the mere contact of two dissimilar metals was first discovered by Rev. Abraham Bennett, in 1789, and that it was verified by a different method by Tiberius Cavallo, in 1795. Meantime, in 1791, Dr. Galvani discovered the twitching of a frog's muscle, due to electrical stimulus. Galvani's discovery was described by himself as follows:[1]

"I had dissected a frog and had placed it upon a table on which there was an electric machine, while I set about doing certain other things. The frog was entirely separated from the conductor of the machine, and indeed was at no small distance away from it. While one of those who were assisting me touched lightly and by chance the point of his scalpel to the internal crural nerves of the frog, suddenly all the muscles of its limbs were seen to be so contracted that they seemed to have fallen into tonic convulsions. Another of my assistants who was making ready to take up certain experiments in electricity with me, seemed to notice that this happened only at the moment when a spark came from the conductor of the machine. He was struck by the novelty of the phenomenon, and immediately spoke to me about it, for I was at the moment occupied with other things and mentally preoccupied. I was at once tempted to repeat the experiment, so as to make clear whatever might be obscure in it. For this purpose I took up the scalpel and moved its point close to one or the other of the crural nerves of the frog, while at the same time one of my assistants elicited sparks from the electric machine. The phenomenon happened exactly as before. Strong contractions took place in every muscle of the limb, and at the very moment when the sparks appeared, the animal was seized as it were with tetanus."

Following this original observation, Galvani made a great many experiments on the effect of electric stimulus upon the nerves of frogs and other animals. He found that the twitching of the frog's muscles could be produced by atmospheric electricity, both at the time of lightning and at other times when no lightning was visible. During these investigations he observed that when the legs of the frog were suspended from an iron railing by a hook through the spinal cord, and when this hook was of some other metal than iron, the muscles would twitch whenever the feet touched the iron railing. He tried out a number of pairs of metals, and found that when the nerve was touched by one metal and the muscle or another point on the nerve was touched by another metal and the two metals were then brought into contact or were connected through another metal or through the human body, the muscles would contract as they would when stimulated by electricity.

Galvani concluded that the contraction in this case, as in the earlier experiments, was produced by an electric stimulation, and since the metals seemed to him to serve merely as the conductors of the electric discharge, he concluded that the source of the electricity must be in the tissues of the animal body. This seemed all the more probable since it was known that certain fishes and an electric eel were capable of giving violent electric shocks. This electricity of the eels and fishes had been named animal electricity, and Galvani concluded that all animals were capable of producing this electricity in the tissues of their bodies.

He believed this electricity was to be found in various parts of the body, but that it was especially collected in the nerves and muscles. The especial property of this animal electricity seemed to be that it discharged from the nerves into the muscles, or in the contrary direction, and that to effect this discharge it would take the path of least resistance through the metal conductor or through the human body. Since during this discharge the muscle was caused to contract, Galvani concluded that the purpose of this animal electricity was to produce muscular contractions.

Galvani seems to have concerned himself principally with the physiological processes which he believed gave rise to the electric charges, but physicists began immediately to seek for other sources of the electricity. The one observation which seemed to offer a definite suggestion as to the possible source of the electrical charge was the fact that, in general, two different metals must be used to connect the muscle and nerve before a discharge would take place from the one to the other. This made Galvani's theory that the metals served merely as conductors seem improbable. On the other hand, it was sometimes possible to get the muscular contractions by using a single bent wire or rod to connect the nerve and muscle, especially if the two ends were of different degrees of polish, or if one end was warmer than the other.

Volta was apparently the first to suggest that the electricity which seemed to be generated in Galvani's experiments might have its source in the contact of the two metals. Several writers called attention to an apparent relation between Galvani's experiments and a phenomenon announced by J. G. Sulzer, in 1760. Sulzer found that if pieces of lead and silver were placed upon the tongue separately no marked taste was produced by either, but that if while both were on the tongue the metals were brought into contact, a strong taste was produced which he compared to the taste of iron vitriol. Here was a case of undoubted stimulation of the nerves of taste by the contact of two metals, and it seemed not improbable that other nerves might be stimulated in the same manner. In the meantime Mr. John Robison had increased the Sulzer effect greatly by building up a pile of pieces of zinc with silver shillings and placing these in contact with the tongue and the cheek.

It was the question as to the possibility of producing the electric charge by mere metallic contact which led Cavallo to make his experiments upon contact electrification. Thus Cavallo says in Volume III. of "A Complete Treatise on Electricity," published in 1795:

"The above mentioned singular properties, together with some other facts, which will be mentioned in the sequel, induced Mr. Volta to suspect that possibly in many cases the motions are occasioned by a small quantity of electricity produced by the mere contact of two different metals; though he acknowledges that he by no means comprehends in what manner this can happen. This suspicion being entertained by so eminent a philosopher as Mr. Volta, induced Dr. Lind and myself to attempt some experiment which might verify it; and with this in view we connected together a variety of metallic substances in diverse quantities, and that by means of insulated or not insulated communications; we used Mr Volta's condenser, and likewise a condenser of a new sort; the electrometer employed was of the most sensible sort; and various other contrivances were used, which it will be needless to describe in this place; but we could never obtain the smallest appearance of electricity from those metallic combinations. Yet we can infer to no other conclusion, but that if the mere combination, or contact, of the two metals produces any electricity, the quantity of it in our experiments was too small to be manifested by our instruments."

Later, on page 111 of the same volume, he goes on to say:

"After many fruitless attempts, and after having sent to the press the preceding part of this volume, I at last hit upon a method of producing electricity by the action of metallic substances upon one another, and apparently without the interference of electric bodies. I say apparently so, because the air seems to be in a great measure concerned in those experiments, and perhaps the whole effect may be produced by that surrounding medium. But, though the irregular, contradictory, and unaccountable effects observed in these experiments do not as yet furnish any satisfactory theory, and though much is to be attributed to the circumambient air, yet the metallic substances themselves seem to be endowed with properties peculiar to each of them, and it is principally in consequence of those properies that the produced electricity is sometimes positive, at other times negative, and various in its intensity."

Cavallo then proceeds to describe the experiments on contact electrification which were described in the previous paper referred to at the beginning of the article.

Cavallo's experiments were evidently made in 1795. In the following year Volta announced the discovery of the electric current. In a letter written to Gren's *Neue Journal der Physik*, August, 1796, Volta says:

"The contact of different conductors, particularly the metallic, including pyrites and other minerals as well as charcoal, which I call dry conductors, or of the *first class* with moist conductors, or conductors of the *second class*, agitates or disturbs the electric fluid, or gives it a certain impulse. Do not ask in what manner; it is enough that it is a principle and a great principle."

It will be seen that at this stage of his discovery Volta was inclined to attribute the origin of the current to the contact between the metals and his moist "conductors of the second class," though later in the same article he says it is impossible to tell whether the impulse which sets the current in motion is to be attributed to the contact between the metals themselves or between the two metals and the moist conductor, since either supposition would lead to the same results.

Later, as was shown in the previous paper by the present writer, Volta came to regard the metallic contact as the cause of the electro-motive force. In a letter written to Gren in 1797 and published as a postscript to his letter of August, 1796, Volta says:

"Some new facts, lately discovered, seem to show that the immediate cause which excites the electric fluid, and puts it in motion, whether it be an attraction or a repulsive power, is to be ascribed much rather to the mutual contact of two different metals, than to their contact with moist conductors."

The new facts, "lately discovered," to which Volta attributes his change of view were his repetitions of Bennett's experiments of 1789.

Volta apparently thought that the current was not only set up by the contact of the two metals of a pair, but that it was kept up by the mutual action of the metals on each other. He accordingly made no attempt to discover whether any changes took place in his circuit while the current was being generated. The chemical action on his metals and the dissociation in his electrolyte seemed to have entirely escaped his attention. At least, he did not attach enough importance to them to mention them anywhere in his description of his apparatus.

In the meantime a chemical explanation of the phenomena observed by Galvani had been proposed in 1792 by Fabroni, a physicist of Florence. After discussing the Sulzer phenomenon already mentioned in this paper, Fabroni argues that the peculiar taste caused by bringing the two metals into contact while on the tongue is due to a chemical, rather than to an electrical, action. He then discusses the different chemical behavior of metals when taken singly and when placed in contact with other metals. He says:[2]

"I have already frequently observed that fluid mercury retains its beautiful metallic luster for a long time when by itself; but as soon as it is amalgamated with any other metal it becomes rapidly dim or oxidized, and in consequence of its continuous oxidation increases in weight.

"I have preserved pure tin for many years without its changing its silvery luster, while different alloys of this metal which I have prepared for technical purposes have behaved quite otherwise.

"I have seen in the museum at Cortonne Etruscan inscriptions upon plates of pure lead which are perfectly preserved to this day, although they date from very ancient times; on the other hand, I have found with astonishment in the gallery of Florence that the so-called 'piombi' or leaden medallions of different popes, in which tin and possibly some arsenic have been mixed to make them harder and more beautiful, have fallen completely to white powder, or have changed to their oxides, though they were wrapped in paper and preserved in drawers.

"In the same way I have observed that the alloy which was used for soldering the copper plates upon the movable roof of the observatory at Florence has changed rapidly and in places of contact with the copper plates has gone over into a white oxide.

"I have heard also in England that the iron nails which were formerly used for fastening the copper plates of the sheathing of ships were attacked on account of contact, and that the holes became enlarged until they would slip over the heads of the nails which held them in position.

"It seems to me that this is sufficient to show that the metals in these cases exert a mutual influence upon each other, and that to this must be ascribed the cause of the phenomena which they show by their combination or contact."

After discussing some of the experiments on nerve stimulation which had been made by Galvani and others, Fabroni argues that these are principally, if not wholly, due to chemical action, and that the undoubted electrical phenomena which sometimes accompany them are not the cause of the muscular contractions.

In discussing the chemical changes produced in two metals by their mutual contact, Fabroni says:

"Since the metals have relationships with each other, the molecules must mutually attract each other as soon as they come into contact. One can not determine the force of this attraction, but I believe it is sufficient to weaken their cohesion so that they become inclined to go into new combinations and to more easily yield to the influence of the weakest solvents."

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* *The Scientific Monthly.*

[1] Translation from "Makers of Electricity," p. 143.

[2] The following quotations from Fabroni have been translated by the present writer from the German of Ostwald's "Elektrochemie," pp. 105, ff.

In order to further show the weakening of cohesion by the contact of two metals, Fabroni describes the results of some experiments which he has made. He says:

"In order to assure myself of the truth of my assumptions, I put into different vessels filled with water:

"(1) Separate pieces, for example, of gold in one, silver in another, copper in the third, likewise tin, lead, etc.

"(2) In other similar vessels I put pieces of the same metals in pairs, a more oxidizable and a less oxidizable metal in each pair, but separated from each other by strips of glass.

"(3) Finally, I put in other vessels pairs of different metals which were placed in immediate contact with each other.

"The first two series suffered no marked change, while in the latter series the more oxidizable metal became visibly covered with oxide in a few instants after the contact was made."

Fabroni found that under the above circumstances his oxidizable metals dissolved in the water, and in some cases salts were formed which crystallized out. He then compares the metals in contact with each other in water with the metals on the tongue when brought into contact, as in Sulzer's experiment, and the two metals touching each other by which different points on a nerve were touched to produce the muscular twitchings in Galvani's experiments, and concludes that the chemical action upon the metals was the same in each case, and that the other phenomena observed must have resulted from this chemical action. It is not strange that when Volta showed later that an electric current passed between the metals in all of the above cases Fabroni should regard the chemical action which he had previously observed as the cause of this current.

Ten years after the publication of Fabroni's original paper, Volta wrote a letter to J. C. Delamethrie which was published in Vol. I of *Nicholson's Journal*. This letter was written after the chemical changes in the voltaic cell had received a great deal of attention by many experimenters, the most prominent of whom was Davy. To show that Volta's theory as to the source of the current was not affected by these investigations, a quotation from this letter is given below:

"You have requested me to give you an account of the experiments by which I demonstrate, in a convincing manner, what I have always maintained, namely, that the pretended agent, or *galvanic fluid*, is nothing but common electrical *fluid*, and that this fluid is incited and moved by the simple *mutual contact of different conductors*, particularly the metallic; shewing that two metals of different kinds, connected together, produce already a small quantity of true electricity, the force and kind of which I have determined; that the effects of my new apparatus (which might be termed electromotors), whether consisting of a pile, or in a row of glasses, which have so much excited the attention of philosophers, chemists, and physicians; that these so powerful and marvelous effects are absolutely no more than the sum total of the effects of a series of several similar metallic couples or pairs; and that the chemical phenomena themselves, which are obtained by them, of the decomposition of water and other liquids, the oxidation of metals, etc., are secondary effects; effects, I mean, of this electricity, of this continual current of electrical fluid, which by the above mentioned action of the connected metals, establishes itself as soon as we form a communication between the two extremities of the apparatus, by means of a conducting bow; and when once established, maintains itself, and continues as long as the circuit remains interrupted."[2]

Further along in the same letter Volta reiterates his conviction that the contact of the two metals furnishes the true motive power of the current. Thus he says (p. 138):

"As to the rest, the action which excites and gives motion to the electric fluid does not exert itself, as has been erroneously thought, at the contact of the wet substance with the metal, where it exerts so very small an action, that it may be disregarded in comparison with that which takes place, as all my experiments prove, at the place of contact of different metals with each other. Consequently the true element of my electromotive apparatus, of the pile, of cups, and others that may be constructed according to the same principles, is the simple metallic couple, or pair, composed of two different metals, and not a moist substance applied to a metallic one, or inclosed between two different metals, as most philosophers have pretended. The humid strata employed in these complicated apparatus are applied therefore for no other purpose than to effect a mutual communication between all the metallic pairs, each to each, ranged in such a manner as to impel the electric fluid in one direction, or in order to make them communicate, so that there may be no action in a direction contrary to the others."

At the end of the above letter as published in *Nicholson's Journal*, the editor, William Nicholson, comments at length on Volta's theory of the source of current in the cell and calls attention to the fact that Davy had already made cells by the use of a single metal and two different liquids. At the conclusion of his comments he calls attention to the fact that Bennett and Cavallo had performed experiments with contact electrification prior to Volta's experiments, and says in conclusion, after referring to Bennett:

"This last philosopher, as well as Cavallo, appears to think that different bodies have different attractions or capacities for electricity; but the singular hypothesis of electromotion, or a perpetual current of electricity being produced, by the contact of two metals is, I apprehend, peculiar to Volta."

This peculiar theory of Volta's probably never gained many adherents and was necessarily abandoned as soon as the energy relations of the current were considered, but the controversy as to whether the electrical current or the accompanying chemical changes was the primary phenomenon soon became transferred to a quite different field, viz., to the origin of the electrical charges which Bennett had shown resulted from the contact of different metals. Bennett attempted to account for the phenomena which he had observed on the hypothesis that different substances "have a greater or less affinity with the electric fluid," and Cavallo says:

"I am inclined to suspect that different bodies have different capacities for holding the electric fluid."

Volta reaches a similar conclusion after repeating some of Bennett's experiments. In referring to this decision of Volta as to the origin of the electric charge in contact electrification, Ostwald says:

"We stand here at a point where the most prolific error of Electrochemistry begins, the combating of which has from that time on occupied almost the greater part of the scientific work in this field."

The error, from Ostwald's point of view, lies in the assumption that the transference of electricity from the one metal to the other is a primary phenomenon of metallic contact. He, with many others, including some of the most distinguished physicists and chemists of the past century, regard the electrical transference as a secondary phenomenon resulting from the previous oxidation of one of the metals. Thus Lodge, in discussing the opposite electrification of plates of zinc and copper when brought into contact, says:

"The effective cause of the whole phenomenon in either case is the greater affinity of oxygen for zinc rather than copper."

The apparent conflict of opinion between those who hold that the different affinities of the metals for oxygen is the cause of the rearrangement of their electrical charges when brought into contact and those who hold with Bennett and Cavallo that the metals in their natural state have different affinities for the electrical fluid, must disappear when we recognize that all affinity, and consequently the affinity for oxygen, must be an electrical attraction. If zinc has an affinity for oxygen, it must be because the zinc is either electropositive or electronegative to oxygen. If it has a greater affinity for oxygen than copper has, then the zinc must be either electropositive or electronegative to copper. This being the case, and both being conductors, it is not surprising that some electricity will flow from one to the other when the two metals are brought into contact.

Those writers who attribute the oxidation theory of contact electrification to Fabroni apparently overlook the fact that not oxidation, but the weakening of the cohesion of at least one of the metals due to their contact, was the primary phenomenon in Fabroni's theory. When this is remembered, it is seen that the observations of Bennett and Fabroni, instead of furnishing arguments for two conflicting theories, actually serve, as all true scientific observations must serve, to supplement each other.

Thus we now know that cohesion or affinity is an electrical attraction between the atoms or molecules of a body. The only known methods of changing the electrical attraction between two bodies whose distances and directions from other bodies remain constant is by varying the magnitude of their charges or by changing the specific inductive capacity of the medium between them. Bennett observed that when two pieces of different metal in their normal electrical condition are placed in contact, there is a redistribution of the charges of their surface atoms. Fabroni observed under the same conditions a change in the surface cohesion of the two metals.

To the present writer this seems the actual sequence of phenomena, viz., a redistribution of the charges of the surface atoms of the metals, a consequent change in surface cohesion and a resultant oxidation of one of the metals.

[2] This seems to be a misprint for uninterrupted.

Mastication and Food Utilization

AGAIN and again in everyday life we find that some dictum which either commends itself to common sense or lends itself freely to argumentative proof is being made the basis of a widespread propaganda. What was more reasonable than to assume that water ingested with meals would dilute the gastric juice and thus diminish its proteolytic efficiency? And what was more logical than to urge the abolition of such an assumedly harmful custom of water drinking? Yet, investigation has showed that some of the postulates in this contention are wrong, and that unsuspected factors further vitiate the conclusions.[1] Indeed, under certain conditions water may even promote the gastric secretion, and thus upset these revered traditions.

The proper mastication of food has certain obvious justifications. It promotes a more extensive insalivation, which is not without advantage to certain types of foodstuffs, and it permits a speedier admixture of the alimentary digestive secretions with the individual comminuted food particles. Enthusiasts have not been content with the insistence on these indisputable advantages, but have attempted to infuse far-reaching effects into the habit of very complete mastication. We may be ready to admit that insufficient mastication is the cause of direct or indirect evils which may be greatly exaggerated in certain pathologic conditions. When, however, we are urged to chew our food with unremitting vigor because it "secures proper insalivation of food, increases the quantity of alkaline saliva passing into the stomach, stimulates the heart and circulation, influences the nutrition of the jaws and their appendages by stimulating blood and lymph circulation, and, finally, tends to diminish the amount of food consumed because it is more economically disposed of in the system," one may well pause to make a few related inquiries. Where is the borderline between "truth and poetry" in these matters?

The two extremes of practice are doubtless represented by under-mastication, as involved in the hasty bolting of food, and over-mastication, to which the epithet "fletcherizing" is sometimes applied. Foster and Hawk[2] have completed studies of the utilization of typical protein as influenced by different degrees of mastication. The principal protein constituent of the diet was cooked beef in the form of 15-millimeter cubes. It happened that protein utilization was most complete as the result of good mastication, and least complete when bolting was practised. The output of fecal nitrogen was highest during the food bolting, and macroscopic meat residues appeared in every stool under such conditions. Yet the discrepancies in the protein utilization during these extremes of mastication averaged only 1.6 per cent.

Such insignificant differences surely cannot be used in support of any enthusiastic claims for the alleged marvelous efficiency of the excessive mastication of food, even when judged by the other extreme of food bolting.

In another recently published series of experiments on man in which vegetable products, notably potatoes and cereal breads, formed the prominent articles of diet, utilization was apparently improved by good mastication.[3] Neither these nor the earlier quoted results are to be taken as an appeal for complete indifference in the matter of eating, but rather as an indication of the rationality of that happy medium of performance in mastication which is usually a sign of physiologic wisdom in other functions.—*Journal of the American Medical Association.*

[1] The Physiologic Effect of Copious Water Drinking with Meals, editorial, *The Journal A. M. A.*, November 30th, 1912, p. 1975; Water as a Gastric Stimulant, January 2nd, 1915, p. 59.

[2] Foster, L. F., and Hawk, P. B.: Gastro-Intestinal Studies, VII, The Utilization of Ingested Protein as Influenced by Under-mastication (Bolting) and Over mastication (Fletcherizing), *Jour. Am. Chem. Soc.*, 1915, xxxvii, 1347.

[3] Abderhalden, E.; Ewald, G.; Fodor, A., and Rose, C.; Versuche uber den Bedarf an Eiweiss unter verschiedenen Bedingungen, Arch. f. d. ges. Physiol., 1915, clx, 511.

Large Grained Metals and the Ball Test

A WRITER in *Comptes Rendus* states that metals and alloys are built up of grains which are anisotropic; the mechanical properties of a single grain will, therefore, be functions of the direction in which the test is made. In the majority of cases the grains are small and the differences are equalized in the aggregate, so that the mass behaves as if it were isotropic. In slowly-cooled cast materials the grain-size may become large enough to render anisotropy evident, more particularly by the ball test. The author has therefore prepared alloys in which the grain-size was purposely made large by very slow cooling from the molten state. Impressions were made by a ball in single grains and measurements in two directions at right angles to each other revealed differences of as much as 29 per cent from the mean value.

Modern Methods of Composing Type

[Continued from First Page]

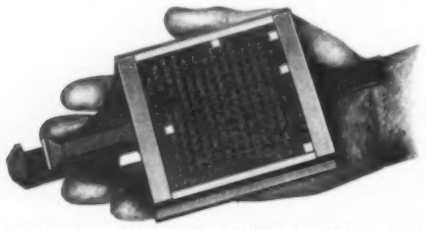
on a rapidly revolving disc, was whirled into species of runway, where it is assembled with others into a continuous row. This row is subsequently divided up by a second operator into line lengths and justified. With improved machines one man can set and justify three to four thousand ems an hour; and with two operators in the neighborhood of 9,000 ems are claimed. The machine handles only one size of type.

It may be explained that the "em" is the unit of meas-

The monotype keyboard.

ure used by printers for measuring composition, and is a square the size of the letter *m* of the particular type in which the matter is set. A hand compositor setting straight matter could average only about 5,000 ems per day.

Although a great number of machines of this class have been invented, it is hardly necessary to mention any here except the Paige compositor, which is unusual and remarkable in many ways. It was probably the



The matrix case contains molds for 225 separate characters.

most elaborate machine of its kind ever produced, and it did composition, justified and distributed all at the same time. The keyboard, which represented 109 characters, could be operated by both hands at the same time so as to bring down entire words at a single stroke, and operators with comparatively little experience could set 12,000 ems per hour. At the end of each word the operator pressed a word key, and another key at the end of each line. This was all the attention he was required to give to the justification, as the machine performed this work automatically, and accurately, measuring the words in each line, and then properly inserting the necessary spaces to correctly fill out the line; the lines were then delivered onto a galley, either solid or leaded, as desired. Three columns of dead matter could be placed on the distributing table beneath the machine, and from this all defective or broken type were rejected, and all inverted type and special characters were separated, after which the regular matter was rapidly distributed. Notwithstanding the wonderful capacity of this machine, which was demonstrated in practical work, it was found necessary to abandon it because the multitude of accurate operations which it performed required fine adjustments that could be made only by a skilled and specially trained attendant, and it was commercially impossible to obtain such men. The machine is said to contain over 18,000 separate parts, and over $2,000,000 were expended in developing it. Only one complete machine was ever built.

TYPE CASTING AND COMPOSING MECHANISM

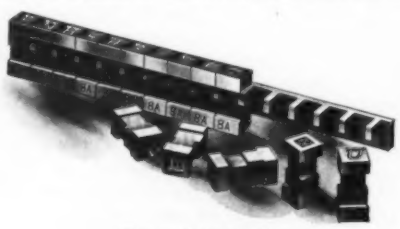
Of the many machines invented for casting and composing individual type as they are required only one has come into practical use, the Lanston Monotype, which has been widely adopted for tabular, book and general work. The monotype consists of two separate pieces of apparatus, a keyboard machine and a casting machine, The keyboard machine is operated by compressed air. and has 256 keys, 225 of which represent characters, thirty represent spaces for justifying and one key returns the parts to their positions after a line has been completed. The depression of a character key operates two punches that perforate holes in a strip of paper, each combination occupying different positions in a line on the strip. When the line of matter being set is nearly completed an indicator shows how much space must be added to complete the line, and corresponding space keys are pressed. After an article has been "keyboarded" on this apparatus the paper strip is transferred to the casting machine, which is operated by a small motor, and also has a compressed air attachment. Besides the melting pot for the type metal and molds for the body of the type and spaces there is a die case which carries 225 bronze cubes, upon the face of each of which is cut the proper

A monotype matrix, full size.

Showing end, side, and face. The cone-shaped hole in the bottom centers the matrix on the mold.

character. These are the matrices, or molds that form the various characters. As the perforated strip of paper passes through the machine the pairs of perforations are presented in succession before corresponding passages, and by this means compressed air is admitted to operate the control mechanism that regulates the movement of the die case so that the proper matrix is brought to a position to correspond with the body mold, when the molten type metal is forced into the mold, and a type of the desired character is cast.

The body mold is fixed as to height, but a sliding blade, controlled by wedges, regulates the width of the body to correspond to the letter being cast, so that the spaces between the letters of a word will be regular and even. In passing through the caster the last holes punched in the paper strip are the first presented to the controlling mechanism, and these are the ones that determine the space necessary for justification. Their action is to adjust the space mold so that every space inserted in the



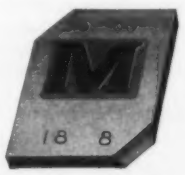
The matrix comb.

The matrices are carried between the teeth of the comb so that each matrix is practically in its own case. All matrices on the same comb produce characters of the same width (set size).

line shall be of an exact width, and of such a measurement that the total of the spaces shall exactly justify or fill out the line to an exact predetermined length. This arrangement insures that each line comes from the machine complete, and of the proper length. Any desired length of line, from seven characters to about ten inches, can be produced automatically

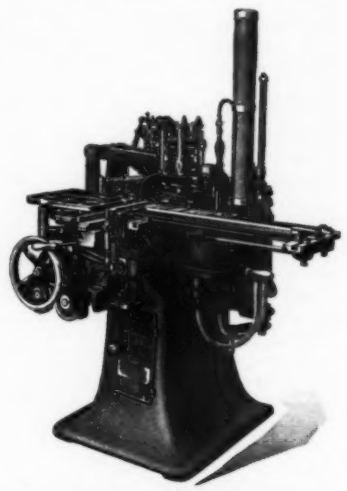
To understand the ribbon let us consider a checker board. The simplest way to locate any square in that board is to name the vertical and horizontal rows, at the intersection of which a given square is located. So, as the Monotype checker board or matrix case contains 225 characters, or fifteen rows each way, this paper ribbon, in controlling the movement of the case over the mold, presents, for example, the ninth horizontal and the eighth vertical (nearly the center of the case) to cast the lower case "k" in the standard arrangement of matrices for book work.

The Monotype machine is capable of producing a much greater variety of sizes of type than any other machine yet devised, and the change from one size to another is effected by the substitution of a set of matrices of the desired kind, and a corresponding adjustment of the body mold. This change does not require very much time, and is easily effected; still, the delay is sufficient



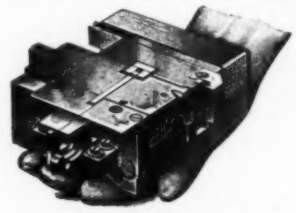
Mold for type casting.

to make it undesirable to use the machine for setting a variety of sizes in the same line, or even in the same page of ordinary printed matter. From this it will be seen that the principal application of the Monotype is in setting considerable quantities of matter in a single size and style of type, as in book work; and for such purposes the machine is very successful and widely used.



The monotype casting machine.

Besides greatly increased rapidity in composition, which means better economy, a valuable advantage of this machine is that every piece of work is set in new type, that has a clean, sharp face, which is a desirable feature in any kind of printing, especially in fine book work. Another useful feature is that it can be used for producing type to be used for hand work, which it does at the rate of 140 finished type a minute, and the great variety both of sizes and of faces, or styles, that it can turn out



The monotype mold mechanism.

has made the Monotype a valuable addition to every establishment doing any considerable amount of varied work. All old type, and "dead" matter is regularly returned to the melting pot, to come out again clean and fresh.

In regular composition the Monotype machine produces justified lines in sizes from 5 to 18 points (or one fourth of an inch), and for type to be used for hand setting it will turn out sizes from 5 to 36 points. It will produce spacing material, borders and ornaments from 5 to 36 points for hand work, as well as leads and metal rule in strips of any length. Two Monotype casting machines will take care of the matter produced by three keyboard machines, and the capacity of one keyboard machine is about 4,000 ems per hour.

A valuable feature of this machine is that after a piece of work has been set, the ribbon can be filed away for future use, as it can be used any number of times, and this saves the expense of holding the type standing, which involves a considerable investment for the metal.

The largest job of composition in the history of printing, the Encyclopædia Britannica, was composed and cast on a battery of 18 keyboards and 15 casters. This leviathan work contains nearly 28,000 pages, 41,000,000 words, and about 200,000,000 ems of type. The type, if arranged together in one line, would stretch across America from New York to San Francisco, and one

[1] The "point" is the arbitrary standard of measure adopted by type makers, and is the seventy-second part of an inch. This standard is applied strictly to the size of the body of a type, as it enables printers to use type from different founders in the same line, but it has little application to the size of the face, or letter printed, as the founder puts any size letter on any body that suits his occasions. Thus, we find an 8-point face on a 10-point base, which was originally done to save the time required to insert a 2-point lead between the lines to open up the matter, the "shoulder" of the type body taking the place of the lead; but actual practice in type making has strayed from the original purpose, so that now there is no systematic correspondence between the nominal size of a type and the size of the letter it bears.

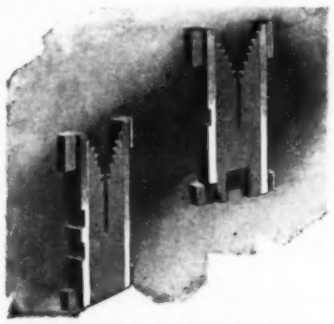
thousand miles out into the Pacific. If weighed, the type would tip the scales at about 250 tons.

SLUG CASTING MACHINES

The third class of composing machines, the slug casting machine, as exemplified in the latest constructions introduced, promises to be more universally applicable than any other system yet proposed, on account of the wide range of work, and the intricate composition of which it is capable. The so-called "slug" produced by these machines is a strip of metal the length of the line, and bearing the type faces upon its upper edge, the entire slug being cast in one piece; and it is made by assembling a series of matrices of the desired letters, properly spaced, in conjunction with a continuous body mold, into which the molten type metal is forced.

The general idea appears quite simple, but it took many years to elaborate the system, and much more time, and the expenditure of immense sums of money, to develop a practical machine. This is the history of the Linotype machine, the one so universally used by newspapers, and largely by makers of other classes of printed matter, and the same is largely true of most other kinds of composing machines. One reason for this condition has been that the inventors began their work with very little, or no previous knowledge of the printing business and the intricate interrelations of the processes of composition, making up the matter in form to be used on the press and the actual press work itself, which involve a multitude of details known to and appreciated only by a practical printer.

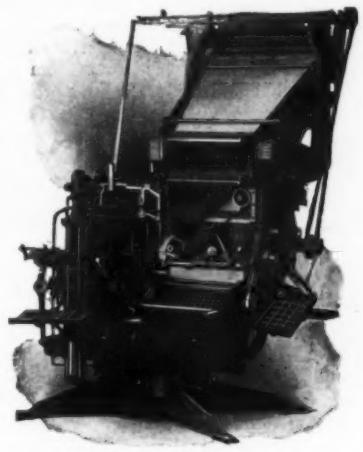
A brief review of the history of the Linotype machine is interesting as showing the vast amount of labor involved in its development, and remarkable persistence



Linotype matrices. The notches in the upper end control the distribution.

and tenacity of purpose shown by its projectors. In 1876 an inventor exhibited to a group of Washington newspaper reporters a crude machine for printing with lithographic ink on paper. The printed matter was cut up and arranged to form columns or pages, a transfer made to a lithographic stone, from which duplicates were printed by the ordinary lithographic process. Some of the men who witnessed this demonstration took up the device, but soon found it not as desirable as they thought, and in their search for a man to improve their device, for none of the promoters were technical or practical men, they found Ottmar Mergenthaler, a clever watch maker of Baltimore, and engaged him for the work. In 1883 Mergenthaler produced a new machine that impressed characters in a strip of papier-mache, thus forming a stereotype mold, but this was quickly discarded for a more elaborate apparatus, somewhat on the same idea, which was brought out in the succeeding year. In 1885 still another machine was completed that had many of the elements of the modern machine, but was still impractical, the first commerical machine not appearing until 1886, since which time its progress has been constant and universally successful, but millions of dollars were expended before this result was attained.

An interesting side light on the development of the Linotype relates to the production of the matrices from which the letters are cast. These matrices are slips of brass which carry in the edge a mold of the letter they



The No. 9 Linotype composing and slug casting machine.

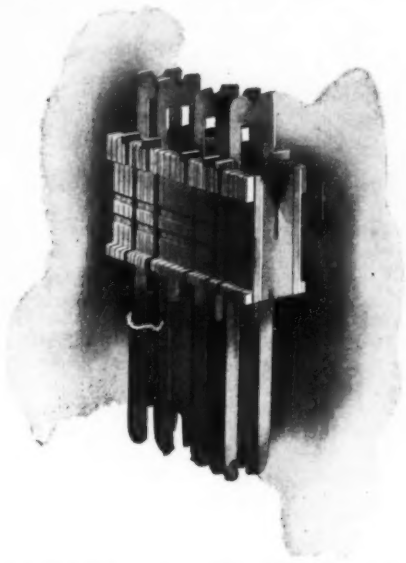
are to produce, and the mold was formed by a hand cut punch. After the Linotype machine had been brought to a practical stage it was found that there were but few men in this country who could cut suitable letter punches, indeed, it would have taken years for the men then available to turn out the number of punches required, for a separate punch of every letter, both capital and small letter, figure and character, and of every different size and style is necessary. This simply meant that the machine could not be used for lack of an essential part, and all the work of invention and development had been vain.

There was still another side to this matter. These punches were liable to break at any time, and it was found that even the best punch cutters could not duplicate a letter so accurately that differences could not be detected, consequently, when a single letter punch was broken the whole set was rendered valueless, and moreover, people who owned matrices from this set of punches could not obtain duplicates to replace losses and wear.

It was certainly a discouraging situation; but fortunately at just this time L. B. Benton, who was then making type in Milwaukee, perfected a remarkably clever machine, operating on the pantagraph principle, that would cut accurately either punches or matrices, and was capable of duplicating any character desired with perfect fidelity. It was a remarkable invention that has had a vital influence on typography generally, and practically all of the printing type of every kind used in this country are produced through its agency. The Linotype people procured some of these machines, and the success of their enterprise was assured.

The general idea of the Linotype has been referred to heretofore, but the general features will be here summed up, although a detailed description would require too much space.

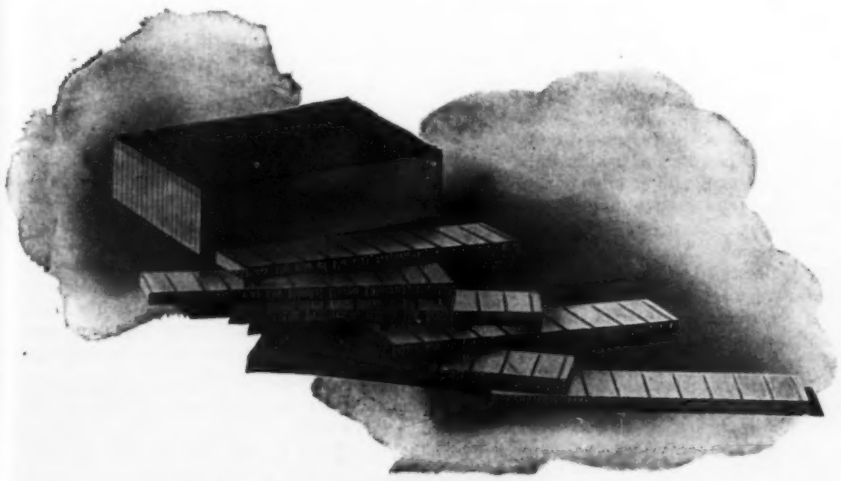
The key to the Linotype idea is the matrix, which consists of a small oblong slip of brass that has either one or two matrices stamped on one edge. If there are two letters they are the same in character, but different in "face" and size. That is, there may be a capital Roman A and an italic *A*, both of the same size. These matrices are contained in a magazine composed of a series of vertically inclined tubes, a separate tube for each letter and character. It is not necessary to have a great number of matrices of each letter, as is the case with hand set type, for after a line has been cast in this machine the matrices used for it are at once distributed and returned to the magazine, consequently all that is required is enough to set three or four average lines, as the first used are back in the magazine before the last one is called for. A keyboard, similar to that of a typewriter, controls the magazine, and on touching a key a single matrix of the corresponding letter is released, and is passed down to an assembling frame. In this way the words to form a line are set in succession, appropriate spaces being interposed. At least three of the spaces inserted in each line are in the form of long, thin steel wedges, and their function is to "justify" the line, or fill it out to an exact predetermined length. This, these wedges or "spacebands" do, after the line of matrices reaches the casting mold, for by driving them up tightly the slight additional space to fill the line is added, and is equally distributed through the line.



A line of matrices assembled, with spacebands in place, showing how the line is justified.

After a line of matrices has been assembled it is transferred to the casting part of the machine, where it is clamped in a frame in conjunction with a mold that forms the body of the line. The "spacebands" are then driven up to justify the line, and molten type metal is forced into the combined mold under pressure by a pump. This metal is drawn from a melting pot that is heated either by gas or electricity, the temperature being automatically regulated. After the line, or slug, is cast it is forced between knives that shave it to exact size, removing all fins, and comes out onto a galley in its due order. The matrices are at the same time lifted to the top of the machine, where they are removed by an ingenious mechanism that carries them across the upper ends of the magazine tubes and each matrix is dropped into its proper channel, ready for further operations.

To control this distribution there are a number of steps cut in the end of the matrix, somewhat resembling the wards in an old-fashioned safe key, each letter having a different arrangement of teeth. These teeth engage with ribs and slots cut in a bar upon which the matrix rides across the top of the magazine, and these ribs are so constructed that they release the matrix at just the proper point to allow it to drop into its proper channel in the magazine. All of the above operations are going on continuously at the same time while the machine is in operation.



Linotype slugs and the manner in which they are assembled.

Linotype slugs are easily handled.

The simple models of the machine as above described can set only one size of type at a time; but it requires only a short time to substitute another magazine carrying a different size, or face; and the body mold is also quickly adjustable for a different size of letter or length of line. This adjustment of the mold can be made to perform still another time saving operation, that of "leading." If type is made up into a page just as it is set up the lines come very close together, so it is common practice to insert a narrow strip of lead between the lines to open up the matter and make it easier to read. This operation was formerly performed by hand, requiring an additional expenditure of time; but with the Linotype machine, the body mold can be adjusted so that the body of the slug is enough thicker than the height of the letter to occupy this extra space between the lines, and so produce leaded lines directly.

In one of the later models the various operations that are possible for this machine are combined in a most ingenious manner, making it possible to do a great variety of intricate composition rapidly on a single machine. This model carries four magazines, each of which carries two letter matrices, and any one of these magazines can be thrown into operation instantly by the movement of a conveniently located lever. It also has four body molds that are capable of quick adjustment. As the magazines can be changed, and the molds adjusted by the operator without leaving his seat; and as there are four magazines, each provided with two letter matrices, the machine will set eight different faces, of four different sizes, and any or all may be used in the same line. By substituting four other magazines, which can be done in a few minutes, another series of eight faces may be used, so that the styles of work possible on one machine are extremely wide and varied. There are 90 keys in the keyboard of this machine, and as each one represents two characters in each magazine, the operator has 720 characters at his instant command from one set of magazines. This machine will set matter in any size from 5 to 42 point, or from one sixteenth to about nine sixteenths of an inch, and as this covers the great bulk of the work that is required in great quantities, including newspaper headings and the majority of advertisements, it is hardly likely that larger machines will soon be required, although it would be possible to build them. It is claimed that 14,000 ems have been set on a Linotype machine in one hour, but the average speed in regular work is about 5,000 ems.

There are one or two other slug casting machines that have been shown to be practical, and which are in use in other countries, but as the United States patents on these are owned by the Linotype people, or their features conflict with other patents, they are not used here. The Linotype machine, however, is extensively used all over the world, and more of these machines are in practical operation than of any other type.

IMPRESSION MACHINES

The fourth and last class of composing machines that will be mentioned are the impression machines, and these cannot be better disposed of than to quote from the "History of Composing Machines," by John S. Thompson, who says "the impression form of composing machines has proven to be the greatest delusion in the art of mechanically setting type, and the records show nothing but abandoned wrecks of attempts to construct machines on this order."

In summing up this class the above writer states: "Some of these machines impressed characters letter by letter; some assembled male dies and made an impression a line at a time. Papier-mache, soft lead, wood and other materials were used to form the matrix. The impressions made were far from perfect, while in impressing letter by letter lateral crowding and distortion were always present." There were still other defects and objections, and the method never came into practical use.

While the great mass of typographic composition is to-day done on machines of various types, the use of hand set type has by no means become obsolete, for there is still a great amount of matter that can be best set in this way, and further there are many kinds of composition that could not be economically set on any machine yet devised; and it may be doubted if hand type will ever become obsolete, unless some entirely different method of duplicating written thought is devised.

The World's Yield of Iron and Coal

THE European war, while drawing heavily upon the resources affecting industries of contending nations, also seriously influences conditions in countries throughout the world not engaged in hostilities, threatening lasting effect and possible future changes in many phases of development. For this reason a discussion is offered of the relative positions of the leading countries which produce pig iron or supply the requisite raw materials for its manufacture, and to indicate past as well as present conditions a period of at least four decades has been chosen as covering practically the era of greatest industrial growth.

Prognostications as to future conditions are not attempted, but analyses of the data presented may suggest possibilities for nations now prominent or others wherein the development or utilization of the above commodities is less pronounced, while similar studies of other industrial specialties may indicate even greater changes.

Iron ore and coal hold leading rank among mineral resources whose development has been and is coincident with the world's progress, for countries possessing these abundantly, or utilizing them liberally, are the dominant nations.

The United States produces more coal, more iron ore, and more pig iron than any other nation, and her strongest competitors are the European countries now at war, for they are each an important factor in the supply of some or all of the above, and, together with the United States, are depended upon for

85 per cent of the iron ore,
96 per cent of the pig iron supply of the world,
89 per cent of the coal.

They are also the most active producers of varied forms of iron and steel manufactures, a large proportion of their inhabitants being skilled and efficient in mine, furnace and mill work.

A disturbance as momentous as that produced by the European conflict is far-reaching in its effect upon industrial progress, and its influence may be expected to continue long after peace is declared: for animosities do not cease with the suspension of active hostilities.

Iron Ore.—Great Britain was the largest contributor of iron ore until 1889, when the United States took first place, and since 1895 Germany has exceeded the output of Great Britain. The contemporaneous contributions of the three nations were practically equal in the years 1893 and 1894, subsequent to which time the advance of Germany and of the United States has been more pronounced than that of Great Britain. In late years the iron ore output of France has materially advanced. The maximum annual productions of iron ore were, for the United States 1913, Great Britain 1882, Germany and Luxemburg 1913,[1] France 1912, Spain 1907, Russia 1911 (?), Sweden 1913, Austria-Hungary 1911 (?).[2]

The majority of iron ores obtained in Spain, Sweden, Russia, and the United States average higher percentages of iron than those in Great Britain, Austria-Hungary, Germany and Luxemburg, France, and Belgium. Hence, the relative weights if iron ore obtained in the different countries may not be considered as equitably comparative, for two tons of ore containing 60 per cent iron will produce as much metal as three tons of 40 per cent ore. The world's output of iron ore approximates 157,000,000 tons, the United States furnishing 36 per cent, and the nations now actively engaged in hostilities in Europe supplying an aggregate of 49 per cent of the total iron ore product of the world. This resource is a most important factor, and it is asserted by some competent to judge that the control of the iron ore deposits of what was then eastern France and Luxemburg had a potential influence in the Franco-Prussian war of 1870, and is a factor in the present conflict.

Pig Iron.—England, which had long been pre-eminent in pig-iron manufacture, was outstripped by the United States in 1890, and in 1903 Germany's product also exceeded that of Great Britain. Some important pig-iron producing countries depend to a greater or less extent upon other nations for iron ore.

The production of pig iron indicates that various commercial forms of iron and steel into which it enters are also locally fabricated. The employment of liquid metal from blast furnaces for steel conversion, and of continuous processes of manipulation used in the manufacture of merchantable metal, causes the district which produces pig iron to attain prominence in supplying various forms of iron and steel, thereby advancing it as an important industrial factor.

To obtain pig iron, ores, fuels, fluxes, and air are required; the last named is sufficiently abundant to cause no anxiety, and fluxes represent a minor part of the "charge." But the average ton of pig iron demands for its production the consumption of two tons of ore and a ton or more of satisfactory fuel. Hence, the nation having its own supply of iron ore, and ample metallurgical fuel of desirable quantity, has an advantage in the race for industrial supremacy. The total quantity of pig iron produced throughout the world is in the neighborhood of 73,000,000 tons. This is exclusive of metal obtained from forges by crude methods in a number of countries. Upon the above basis the United States at present supplies 41 per cent, and the combined output of the European nations in conflict is 55 per cent of the world's pig iron product.

Coal.—England maintained pre-eminence in coal output until 1898, but since that date the United States has been in the lead, and in 1913 produced almost as much coal as its nearest competitors, Great Britain, Germany and Luxemburg, combined. The United States supplies more coal than all of continental Europe; in fact, as much as the balance of the world excluding Great Britain—39 per cent.

The coal product of the United States and Great Britain averages higher grade than that of continental Europe, where large quantities of lignite or brown coal are secured, but the statistics given include the production of anthracite, bituminous, and lignite or brown coal.

In round numbers the total annual production of coal in the world at the present time is 1,250,000,000 tons, of which the United States contributes between 38 and 39 per cent, and the combined output of the European nations now at war approximates 50 per cent.

According to latest official comparable data, the countries mentioned rank in volume of products in the following order:

Iron ore.	Pig iron.	Coal.
United States,	United States,	United States,
Germany,	Germany,	Great Britain,
France,	Great Britain,	Germany,
Great Britain,	France,	Austria-Hungary,
Spain,	Russia,	France,
Sweden,	Austria-Hungary,	Russia,
Russia.	Belgium.	Belgium.

The population of the countries and the relation which this bears to the quantities produced are of interest.

Thus, in per capita production, the nations rank:

As producers of iron ore.	As producers of pig iron.	As producers of coal.
Sweden,	United States,	Great Britain,
United States,	Belgium,	United States,
Germany,	Germany,	Germany,
France,	Great Britain,	Belgium,
Great Britain,	France,	France,
Austria-Hungary,	Sweden,	Austria-Hungary.
Russia.	Austria-Hungary,	Japan,
	Russia.	Russia.

—From a paper read by John Birkinbine before the Franklin Institute.

[1] The statistics of Luxemburg, which supplies liberal quantities of iron ore and coal, have been officially combined with those of Germany.

[2] (?) intimates that no authentic records are available subsequent to the date mentioned.

Preserving "Caste" in English Hospitals

THE employment of men from the East Indies, among whom caste customs are strictly observed, in the British fighting line in France has brought about unusual conditions. How this "caste" question affects a hospital is told in a London letter in the *Medical Record*. The hospital referred to is located at Brighton, and the correspondent says:

"Major S. James, chief of the hospital, which is equipped for two thousand patients and is run by officers of the Indian medical service, described the provision made for enabling Indians to live in accordance with the customs of their own country, and pointed out various conditions which must be strictly observed to prevent patients losing caste. They had to serve eight separate diets, cooked in twenty-one cookhouses in the hospital grounds, for the patients. For the staff sixteen other cookhouses were in use in the village. The Hindu cooks have to be of the same caste as the patients they cook for, or else higher. No beef is allowed inside the hospital, as the cow is a sacred animal to Hindus. Bacon and pork are also prohibited. As Indians must themselves slaughter the sheep they use for food, and in their special manner, a slaughter house has been provided for them. Hindus sweep off the head of the animal with a single stroke of a talwar or sword. For Mohammedans the mouth of the animal must be pointed toward Mecca.

"The hospital requires 60 or 70 gallons of water per man a day—not so much when it is remembered that an Indian must bathe before prayer, and that a good Mohammedan must pray five times a day. The flooding of the bathrooms is a common trouble, as the patients neglect to turn off the water. Before the electric light was in use they persisted in blowing out the gas, so there was always danger of poisoning. As Hindus who die must be cremated by members of their own caste, a site has been set apart for this, and the funeral ceremonies can be carried out as precisely as in India.

"Mr. Clement (Deputy Surveyor) estimated the consumption of water at the Kitchener Hospital as over 100 gallons a day. He added that one amiable failing of the Indian was to turn on the hot water and wait till it cooled to a comfortable temperature for bathing."

MANY preparations have been put on the market for quickly removing the carbon from the cylinders of gasoline engines. The latest to appear is acetol, which is a liquid that is applied by injecting through the spark plug opening. It is claimed that the carbon is rapidly softened, and the detached material is blown out through the exhaust when the engine is restarted.

Titanium and Its Effects on Steel

Some of the Results Secured by This New Oxidizing Agent

TITANIUM is widely distributed in the earth's crust in small quantities and is always found as an oxide, its principal ores being rutile, the fairly purely dioxide and ilmenite, a mixture of iron and titanium oxides. One of its chief peculiarities is the readiness with which it combines with nitrogen. It is one of the very few elements which will "burn" in an atmosphere of nitrogen. Its dioxide is one of the most stable compounds known, and great energy is required to decompose it. Thus it follows that when titanium is separated from its oxygen, it will readily re-combine with it, with evolution of heat. The value of titanium in the steel industry is due largely to the fact that its dioxide is so much more stable than iron oxide that its action in "deoxidizing" melted steel is very powerful.

The reduction of the natural oxides is effected either by reduction with carbon by means of the electric arc or by an alumino-thermic reaction. The former process delivers the titanium in the form of the carbide, while the latter produces an alloy of titanium, aluminium and iron. The carbide is the form most generally used.

Metallic titanium when heated to redness in nitrogen forms titanium nitride, but when heated in air only the oxide is formed. The nitride is slowly converted to the oxide when heated to redness in air, but the carbide burns vigorously in air, forming dioxide. The reverse reaction takes place only at very high temperatures. Even at the temperature of the blast-furnace titaniferous ores do not give more than 1 per cent of titanium in the pig-iron. This is probably present partly as carbide and partly as cyanonitride. Although in the blast-furnace titanium nitride is sometimes formed, it is not present in the titanium-carbide alloy used in treating steel, for at the temperature of the electric-arc furnace, in which this alloy is made, with a reducing atmosphere and excess carbon the nitride is dissociated in favor of the carbide.

For general effectiveness titanium is the best of the various deoxidizers for steel. The carbide gives results quite as good as the pure metal and is much cheaper. A material is sold at 8 cents per pound containing 15 to 20 per cent Ti, and known as "Ferro Carbon Titanium." It consists of microscopic particles of titanium carbide held in a matrix similar to grey cast iron. When added to melted steel the matrix dissolves quickly, and the particles of titanium carbide are rapidly diffused through the bath, where they react vigorously on the oxygen.

The aluminothermic alloy, which contains very little carbon, is an alloy of aluminium and titanium in iron, and hence its use involves the production of the effects of both these elements. The chief objection to its use is the harmful effect of aluminium in hindering the removal of oxide and slag enclosures.

Titanium oxide acts as a flux for silicates and other slags that may be in the steel. The best cleansing action is obtained when the titanium is added without aluminium, or in the form of the carbide rather than as the aluminothermic alloy. The latter should only be used in the few rare cases where the addition of the carbon of the alloy would be undesirable. In soft steels the increase in carbon from this addition would not be more, than about 0.01 per cent, so that the cases where this would make any material difference are very few indeed. Practically all the titanium used in steel in America at the present time is in the form of ferro-carbon titanium a large percentage being used for rail steel, although its use in other steels is growing steadily.

"Titanium steel," properly speaking, is not made commercially at present. Such a title naturally implies a steel whose properties are dependent to an appreciable extent on a certain content of titanium. The advantages of the titanium-treated steels as made to-day are due to greater soundness, cleanness, and less segregation, and not, as far as is known at present, to the small amount of titanium left in the metal. In no case has over 0.025 per cent of titanium been found in any sample of titanium-treated steel analyzed at our laboratories. It is very difficult to make steel absorb more than 0.025 per cent titanium under the usual conditions of manufacturing, and no use has yet been found for steel containing larger quantities that would warrant the attempt to produce commercially a real "titanium steel."

Steels made by the Bessemer, open-hearth, or crucible processes are treated with titanium, but most of this element is used in open-hearth steel. The alloy is furnished in various sizes, from lumps of about one inch diameter to powder, according to the quantity of steel to be treated at one time, and for the best results it must be added to the melted steel as it flows from the furnace to the ladle. After the addition the steel must be kept in the ladle for from three to ten minutes, depending on the size of alloy used and the mass of steel treated. Then the steel is teemed as usual into moulds where no further additions should be made. The amount of alloy recommended for use in rail steel is 13 pounds per ton, which means an addition of 0.1 per cent of metallic titanium. A higher grade alloy is not used because its rate of solution in the melted steel is slower. The price of rails treated in this way is increased about 5 per cent. For castings and soft steels a smaller amount of alloy may be added. Low-carbon steels always contain blowholes even if treated with titanium but the steel being normally cleansed by the titanic oxide, they are free from slag and are closed up when the ingots are worked. If they become oxidized, however, or contain slag, they will open up as seams or remain as slag inclusions in the metal. It is well known that if steel is completely deoxidized and no blowholes are formed, a large shrinkage cavity, or "pipe" will form in the center of the upper part of the ingot. Titanium may cause piping, as well as other deoxidizers, but by properly designing the moulds piping may be controlled so as not to give much trouble.

The dependence of segregation on deoxidation is less obvious than that of soundness. Primarily, segregation is due to selective freezing. The freezing point diagram of the iron carbon alloys shows that with ordinary steel the first metal to freeze is of lower carbon content than the remaining liquid, and the last liquid to freeze is of higher carbon content than the already frozen solid. But with well-deoxidized steel this selective freezing takes place in a quiet mass of pasty material, and the higher-carbon liquid is so intricately entangled in the lower-carbon solid that it does not have a chance to gather in the center of the ingot to any great extent, and is finally frozen together with the lower-carbon material. If this steel is not well deoxidized, but gives off gas during solidification the gas rises and opens up passages thro ugh the steel, taking with it a little of the higher carbon liquid toward the top and center of the ingot and leaving the solid lower-carbon material behind. This action will result in the formation of a large body of higher-carbon material in the upper part of the ingot, or, in other words, there will be excessive segregation. Phosphorus is subject to this action in the same way as carbon, and sulphur, existing in the steel as small non-metallic globules composed of a mixture of iron and manganese sulphides with a freezing point not much, if any, higher than that of the metal, is even more affected. For this explanation of the relation between segregation and oxides in steel the writer is indebted to Mr. N. Petinot, metallurgist of the Titanium Alloy Manufacturing Company.

Aluminium and probably also vanadium and silicon have an effect on segregation similar to that of titanium, but with vanadium the cost would be higher, and with silicon and aluminium impurities would be added to the steel. In most rail steel that has been properly treated with titanium, very small angular pink inclusions can be found with the microscope. These are titanium nitride, possibly contaminated with carbide. An average of many nitrogen determinations on titanium-treated rails shows a distinctly lower amount present in solution in the metal than in untreated rails. If it is assumed that nitrogen has an injurious effect on steel, the lower amount must be an advantage, for even if the whole amount removed from the metal itself is still present in the pink inclusions, it could have no more ill effects in this form than any other non-metallic inclusions of the same size. As the titanium nitride inclusions are never found segregated in groups or streaks, like alumina and silicates, but are always very small and thinly scattered, their weakening effect on the metal is practically negligible. They have been found in titanium-treated steel axles as well as rails, but not in steel castings or soft steels where smaller amounts of titanium have been used.

Some so-called "titanium-treated" steels have not been any better in regard to segregation than the average untreated steel. These have constituted, however, an insignificant percentage of the total number examined in these laboratories. In every case these segregated "treated" rails have not shown a titanium content of over 0.005 per cent (while the average treated rails are well above that figure), and the pink nitride inclusions have also been absent. These facts indicate that not enough titanium was added to produce the usual effects. In the case of deoxidation of steel with titanium an excess of probably at least 0.005 per cent is necessary.

Forty-two samples of plain and treated open-hearth steel rails have been exhaustively tested, physically and chemically, in these laboratories.

The samples have all been taken from the "A rails" or first rails rolled from the ingots, after the usual discards from their tops, thus representing in each case metal from the top part of an ingot, which would show the greatest amount of segregation and impurities. The samples were always taken in pairs, one treated and one untreated from each rolling, so that in the final comparison the influence of the conditions of manufacture could be as far as possible eliminated. The final averages of the results are here tabulated.

Chemical analyses were made at four places on each rail—at top of head, center of head, web, and flange. The lowest and highest figures for each rail were averaged together, giving the average low and high results:

	Untreated Rail		Treated Rail	
	Low.	High.	Low.	High.
Carbon	0.58	0.82	0.63	0.76
Manganese	0.71	0.78	0.75	0.79
Phosphorus	0.016	0.026	0.018	0.023
Sulphur	0.032	0.058	0.031	0.040
Silicon	0.117	0.131	0.090	0.099

The following figures relate to tests on the head of the rails:

	Untreated Rails.	Treated Rails.
Elastic limit	56,071	59,738
Ultimate strength	118,138	124,857
Elongation	12.8 p. c.	13.1 p. c.
Reduction of area	14.3 "	15.4 "
Brinell hardness	220	226
Impact resistance (Fremont machine)	1.47	1.58
Endurance (*a*)	1,312	1,280
Endurance (*b*)	16,500,920	23,923,628

(*a*) By Landgraf-Truner machine. Alternate bendings endured before fracture.
(*b*) By White-Souther machine. Revolutions before fracture.

The improvements in other rails, from lower positions in the ingot, would be much less marked, but the rails that give most of the trouble in service are the segregated "A" rails, and these are rendered practically uniform and homogeneous as the other rails by treatment with titanium. Titanium-treated rails are not better probably than the best possible untreated rail, but by this treatment the general standard of quality is unquestionably raised, uniformity is more nearly attained, and the bad heats of dangerously segregated or dirty steel are avoided.

To acquire still more positive data on the effect of titanium on segregation in rails, 79 "A" rails from different untreated heats and 31 similar rails from different treated heats were examined recently by means of sulphur prints and chemical analyses for carbon made on each at an upper corner of the head and at the junction of head and web. The average difference between these two points was 17 per cent for the untreated rails, and the worst rail showed 40, while only 29 of these 79 rails showed less than 12 per cent. For the treated rails the average difference was 3.1 per cent, and the worst one gave 11.5 per cent, none of the 31 showing over this amount.

The railroads have been acquiring data for some time in regard to the wear of titanium-treated rails in track as compared with that of ordinary open-hearth rails. The results have been uniformly favorable to the treated rails, in some cases very decidedly so. For instance, on a sharp curve on the Boston Elevated Railway titanium-treated rails laid alternately with plain rails of practically the same composition showed 41 per cent less wear after 214 days' service. In a test made by the Rock Island Railroad titanium-treated rails in seventeen months had 0.014 square inch abraded from their sections on the average, while electric steel rails showed under the same conditions a loss of 0.058 square inch and ordinary rails 0.075 square inch.

In axle steel it has been found similarly advantageous to use titanium for purifying the metal and preventing segregation. In steel castings the use of titanium as a deoxidizer has usually been successful and satisfactory, and in soft steel for plates and thin sheets much titanium is used. This element is preferred to any other deoxidizers because it does not leave any product of its oxidation in the steel, as aluminium and silicon do, and the ingots therefore roll out smoother and the finished sheets have a better surface. Small defects on the surface of a sheet are very serious in galvanizing, so that the smoother surface of titanium-treated sheets, due to cleaner ingots, is much appreciated.—By George F. Comstock in *Chemical Engineer*.

One of the scenic groups of pond life at the American Museum of Natural History.

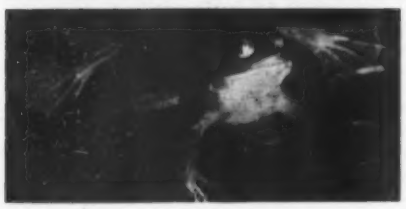
Making Natural History Popular

Attractive Museum Groups of Our Common Pond Reptiles

By Warren H. Miller

ALONG with the stuffed animal and the bird-on-a-stick, the spirit jar containing the mortal remains of some hapless reptile has been relegated to the limbo of forgotten things in our great American natural history museums. Over twenty years ago it was realized that to interest the nature-loving public something more was required in presenting our birds and animal life than rows on rows of stuffed specimens. The plain people saw, as the scientists apparently did not, the essential falsity of such a presentment of our wild life and demanded something better; demanded, in a word, cases showing the life history of each species, its environment, the kind of spot that the birds, for instance, select for a nesting site, their nest and the eggs, the young and the parent birds, all mounted as in their own wild homes. So came into being the "environment case" which set forth the natural history of our commoner bird species. Followed the scenic cases, in which not only the environment but the typical wild scenery in which characteristic groups of birds might be found, was shown in large cases having a panoramic painted background into which the natural foreground shaded so imperceptibly as to present to the eye a typical wilderness scene, and these groups were selected from widely different parts of our big country, no less than twenty-five of them now being on exhibit in the Bird Hall of the American Natural History Museum in New York. At the same time the wild animals received their share of attention in the wonderful sculpture-taxidermy methods of mounting, the environment cases being on the same general plan, but, of course, on a much larger scale than those of the birds.

Gobbling a handful of snakes.



Watching his chance to catch a bird.

And now comes the presentation of our common pond reptiles and amphibia by the same interest-arousing method. Most of these little known and less appreciated creatures are beautiful and all are interesting to study, but so long as they were exhibited in the museums in the shape of loathsome discolored specimens in rows of glass spirit jars, the public, far from feeling any interest in them, felt rather a positive repugnance, and this was accentuated by the general ignorance and superstition that most people have concerning reptilian life.

But, set these same creatures before us in the beautiful and familiar aquatic scenes in which they live, make them tell their life story in characteristic ways, let us see how pretty and interesting our woodland frogs, toads, lizards—yes, even snakes—really are, and the same nature-lover who could hardly be induced to look at the old-style reptile hall with its preserve jars of discolored and formless reptiles, will study avidly such aquatic scenes as are here set before him.

This the American Museum of New York now presents in four scenic cases, composed under the direction of Miss M. C. Dickerson, Curator of Reptiles, and showing the natural history of our brook salamanders, our bullfrogs, tree toads, wood toads and lizards set in the familiar ponds and pools in which are enacted their life histories.

Perhaps the most interesting, because of its universal popular appeal, is the pool showing the natural history of the bullfrog. He is such a comical chap, so familiar to us all from our earliest boyhood days, and somehow manages to get himself so much in the limelight in any pond in which he may find himself, that we love to learn all we can about him and his ways. This case shows us a typical summer pond or backwater grown up with lily pads and blue-spike water lilies, surrounded with water-loving bushes in full bloom, and the background is a great forest through which the hot noon-day sun filters. A scene to make any nature lover sigh for the green woodlands again! We gaze at it and wonder at the marvelous artistry that could present nature so vividly, and perhaps we breathe a whisper of appreciation for the loving devotion to science that moves the museum curators and preparation experts to devote their lives to this sort of work.

But the inhabitants of the pool soon claim our attention. Here is a big bullie swimming at full speed under water, leaving a trail of bubbles behind him. He has evidently been scared into jumping by our presence, but why the trail of bubbles? We learn that he expels the air from his lungs as he dives, and forthwith breathes through his skin while under water. Here is another one, cramming a whole mouthful of young water snakes into his capacious maw, using a very human-like hand, for all the world like a small boy gobbling a morsel of cake. Still another is looking up expectantly at a deer mouse which has just come down the bank to drink; evidently fur, feathers or fish are all game for the bullfrog, for here is another trying to make a leap for a chickadee perched on an azalea bush overhanging the water. The commotion started by the frog who dove for safety has communicated itself to the rest of the pool, for here are two infinitesimal water turtles scrambling up atop a pond lily leaf for safety; a large painted turtle is just diving off a log, and two small sunfish are just disappearing into the still dark depths under the blue-spikes. In the immediate foreground are two more full-grown bullfrogs, one just having caught a bumblebee off the azalea with his extensible tongue, and the other is is process of shedding his skin and eating the old caul as it comes off—that nothing be lost in Nature's economy!

Tadpoles of the species, some newts, a dragon fly, some young bullfrogs just over the tail-losing period, and a couple of half grown ones complete the group. One of the latter is in imminent danger of his life, for we perceive a large black snake winding his way down from the azalea branches, and another bullie that has noticed him is giving a very good imitation of a mossy stone, "freezing" in a huddle as still as a rock, for he knows well that the snake's eyesight is none of the best—provided that nobody moves! The bullfrogs for

Eating his cast-off skin.

A realistic reproduction of the edge of a pond with water plants, and showing incidents of the daily life of the frog.

A quiet pool teeming with various forms of reptile life. The frogs in this group were cast in wax directly from etherized specimens.

this group were cast in wax from life, the recently etherized specimen being posed from a similar live one, cast in a plaster-of-paris mold and colored true to life by museum preparation experts. The group showing us the life story of the woodland tree toads and ground toads presents our familiar forests in May; the May of the wild flowers—dog-tooth violet, jack-in-the-pulpit, anemone and Solomon's seal—so dear to the memory of all of us who have roamed the fresh green woods in the spring in quest of flowers. But, how newly interesting is this quiet pool, with its still, clear waters and mossy banks! How familiar, yet how different it all is! For this pool teems with small reptile life, perhaps never before noticed in our rambles afield, now brought forcibly to our attention because of the great number and variety of forest frogs, toads and hylas, from the tadpole to the full-grown creature, that are here assembled. Nearly everyone will recall the vocal efforts of the spring "peepers" that sound from every pond and puddle in early spring; also that squalling cry that resounds far and near around our ponds in May. The first is made by the hylas or tree toads, and the second by the ground toads, for both their mating cry. For the latter this group shows how the sound is made, for here is one swelling up that translucent sac that you will note under his chin. The contained air is allowed to pass back and forth over the vocal cords, thus producing the sound. Here in the depths of the pool are the egg masses and tadpoles of each species, all differing and worthy of special study; the young "toadarettes," the small garter snakes that prey upon them; the big water snakes that seize unwary full-growns—all the interesting story of food getting and family life of these little-known creatures is here set forth. It is a fascinating group to study, and Miss Dickerson's clever artistry in leading the eye unconsciously from one feature of interest to another aids materially in the pleasure derived by the observer.

It is a great thing that the museum scientists have done in making it possible for the city dweller to observe Nature by bringing her to us, inside the city gates, and presenting before us all the biological facts that they have gathered in years of field studies.

Yet another group; a wild, stern scene that few of us will ever look upon; that red volcanic desert of Lower California that extends into the Painted Desert region of Arizona. Here are the many-colored lizards that scamper across the thirsty wayfarer's path; the big red rattler that makes his lair under a thorn bush; the iguana that finds a living in these arid solitudes, and the ugly Gila monster, the only poisonous lizard known. The vegetation is strange and different—cactus, ocatilla, prickly pear, spiked choya, palo verde—all of it is fascinating to the nature student.

The case at the extreme left of these groups is another familiar aquarelle, a big trout brook flowing right out of mountainous forests into the observer's lap, as it were, so strong is the verisimilitude of running water obtained by the legerdemain of the museum preparators. The scene is typical of a mountain trout brook; there, in the background, is a kingfisher, darting down to prong a minnow; water-loving birds are at their life work of keeping down the insect population in the bushes overhanging the stream; while, in the foreground, deep in the clear, rocky recesses of the brook, we note the giant salamanders, those strange creatures which inhabit our brook bottoms. How they live and grow up from the egg stage, how they catch the unwary brook

Disposing of a bumblebee.

dace and fight among each other for the possession and devouring of each other's eggs; how live the allied species of smaller salamanders that one is likely to find in such places, all is here set forth, all telling its own story to the observant eye. And, of course, the picture would not be complete without a placid frog, observing events from his mossy dell on the banks, and he is here, by no means overlooked in the composition of this group.

All these curious reptiles are interesting, for their forebears were also the remote ancestors of ourselves. From them they and we descended, and here we see the reptilian branch of the great tree of evolution so highly specialized for just one scheme of existence, so absolutely dependent upon water to earn a livelihood and escape enemies as to have reached an entire standstill in the process of evolution. Yet some remote ancestor of theirs, which managed to emancipate himself from aquatic life, undoubtedly evolved into the modern mammal species, and from them came Man. These creatures whose life story is set forth in these cases represent reptilian life that has branched off the main trunk and come to a standstill, unchanged except in diminution of size and power, so that the future of their race seems fixed, forever arrested by the high state of specialization for one particular mode of life in which we here find them.

A Great Commercial Railway

In developing their East African territory the Germans last year completed a great railway system from Dar-es-salaam on the coast, 780 miles long, extending into the interior. This road penetrates the country bordering on the three great African lakes, Nyassa, Tanganyika and Victoria Nyanza, and the region of the Upper Congo, linking up these important and rich trade districts with the ocean, and calculated to divert commerce from the adjoining English territory around and to the south of the lake region. At Tabora, where many great trade routes converge, 530 miles from the sea, a strong modern fortress has been built; evidently with the purpose of clinching their hold on the commerce of that region.

The Passing of the Bertillon System of Identification*

An Elaborate System of Measurements That Has Been Displaced by Simpler Methods

By Raymond B. Fosdick†

In the death of Alphonse Bertillon, in February, 1914, the anthropometric method of identification probably suffered its final blow. For a decade his prestige and personality were the only supports of a system that in Europe, at least, had been fast losing ground. Persistently, even stubbornly, he endeavored to save the method which was the product of his genius and which bore his name, but he lived to see it discarded in nearly every country in Europe except his own. And even in France, now that the weight of his influence and his really compelling personality are gone, it is doubtful whether his system of identification will be continued.

To realize the significance of this fact, it is necessary first to understand the importance of a system of identification in the problem of crime detection. Intelligent police action is to-day based primarily on criminal files. Detectives and magistrates alike must be acquainted with the criminal propensities of specific individuals; they must be armed with accurate knowledge of the past records of those whom they arrest or suspect. Such records as these, however, classified merely by names, do not in themselves furnish an infallible instrument. Without an accurate method of identification, the simple invention of an alias or any other disguise, will if undetected, invalidate the entire system. Indeed, the usefulness of criminal records depends upon the ability of the police to fasten upon each human being an identity from which he cannot escape. Criminals must be differentiated from the rest of the population as well as from each other. Means must be discovered to prevent a person guilty of crime from losing or destroying his identity. Formerly the police were forced to depend on descriptions and photographs, but these methods proved by no means reliable, for the modern criminal is an adept in altering his personal appearance. More certain methods were essential, and for years the science of crime detection concerned itself largely with the search for an infallible system of identification.

When, therefore, in 1883, Bertillon announced an exact method of identification by means of measurement he placed the entire world in his debt. His system was adopted in nearly every civilized country. England, Germany, Austria, Russia, Switzerland, and many States in the United States applied it in their police departments, and the Bertillon cabinet became the distinguishing mark of the modern police organization. During this time, Bertillon was constantly developing his identification methods. To the measurements he added, as sub-classifications of his system, his famous descriptive photography (*portrait parle*) and his method of grouping colors and characteristic marks. Later, as we shall see, he added finger-prints, producing the so-called *Parisian fiche*, which is made up partly of bodily measurements and partly of papillary line patterns. Of the ten fingers, Bertillon utilized at first only four of the left hand. Only recently did he consent to use all ten. The Bertillon criminal card, therefore, while classified by means of measurements, involves other methods of identification.

It cannot be denied that the Bertillon system is soundly based on scientific principles. Accurately measured, no two people will ever show the same dimensions. In 1913, the writer spent a week with Bertillon in the *Bureau de l'Identite Judiciaire* in Paris with every facility for study and examination. Probably a more wonderful collection of criminal records has never been got together, and surely no greater genius than Bertillon ever presided over a bureau of identification. If all the investigating officers the world over had his power of analysis and arrangement and his patience and skill in handling details, the anthropometric system might even yet be the predominant method of identification. Bertillon's ready hand could pick the card that he wanted out of thousands in the file in hardly more than a moment, and in experiment after experiment which he conducted for me he showed not only the amazing accuracy of his system, but his own easy grasp of all its intricate details. In the thousands of measurements that had passed through his hands no two had ever been found alike. Indeed, he assured me that no two had ever even approximated each other enough to cause a moment's hesitation in his mind.

But his system of identification is not without its obvious defects. To begin with, it cannot successfully be applied to women or children, as it is based on the measurement of unvarying portions of the human frame, between adolescence and old age. Children before full physical maturity are obviously eliminated, while a woman's hair, to say nothing of recurring pathological disturbances, makes exact measurement almost impossible. Bertillon himself frankly admitted this gap in his system and later supplied the deficiency by a separate finger-print file for women and children, which, with characteristic independence, he classified, not after the Henry or Vucetich method, but after a method devised by himself.

Another drawback to the anthropometric system lies in the fact that the instruments used for measuring, necessarily of delicate construction, are likely to get out of order. The writer has seen in use in a southern city in this country a pair of calipers so bent that the results obtained were three millimeters out of the way. Again, in making the measurements a margin for error must always be allowed as no two officials find exactly the same dimensions. This margin of error is not fatal to the system, provided the measurements have been made with a fair degree of accuracy. But to take measurements with even a fair degree of accuracy requires special training, and in many cities such training is not to be had. Indeed, in America at least, training along this line is the exception rather than the rule. In some of our southern and middle western cities, where, as a matter of fact, the Bertillon system seems to be regarded as a fetish rather than a scientific method of identification, I have seen so-called experts measuring prisoners without even a knowledge of where to place the instruments, obtaining results so ludicrously inaccurate as to eliminate any chance of identification.

But a system must be judged by its use rather than its abuse. Even in Europe, where the Bertillon method has been tried under the most favorable circumstances, there has been constant complaint of its inaccuracy—or rather of the difficulty of using it with sufficient skill to produce accurate results. Primarily it is a system for use by highly trained men. Bertillon's genius was far above that of the average police official, either in Europe or America.

However, the Bertillon system has lost its hold not so much through its own inherent defects as through the creation of a better and simpler system—dactyloscopy. Largely the work of Sir William Herschel and Sir Francis Galton, this system was first made really practicable for police purposes by a method of classification devised by Sir Edward Henry, now Commissioner of the Metropolitan Police Force of London. After a trial by the English authorities in India, the system was introduced at Scotland Yard in 1901. Its astonishing success there was soon brought to the attention of police authorities in other countries and in the next five years it was introduced widely throughout Europe. Still later it was taken up in the United States. It is noteworthy that the Henry system of classifying finger-prints is still the one most widely employed, although other methods of classification have since been devised. The Henry method is used in most of the cities of the United States, in Great Britain, Holland, Belgium, Austria-Hungary, Switzerland, and in Germany, with the exception of Hamburg and Berlin. In these two cities a modification of the Henry system has been adopted.[1] Rome and other Italian cities use the "Argentine system," invented by Vucetich, and widely employed in South America. Adaptations of this system are used in Madrid and Copenhagen and in Norway and Sweden. In Boston, Massachusetts, and in Newark, New Jersey, the so-called Conlay method of classification, brought from Singapore, India, is employed. While each of these various methods has, no doubt, valuable features, it is not the purpose of this article to discuss their relative merits.[2] The utility of the finger-print system of identification is not affected by divergences in methods of classification, nor is the exchange of finger-prints between departments in any way hampered. Finger-prints taken by the police of Rome are readily intelligible at Scotland Yard, and *vice versa*, in spite of the fact that Rome classifies her dactylograms after the Vucetich method, while London follows the Henry system.

But while it is possible thus to harmonize the different methods of finger-print classification, there can be no harmony between finger-prints on the one hand and measurements on the other. These two systems of identification have nothing in common. Each claiming to make the existence of the other unnecessary, they have from the start been bitterly antagonistic. Bertillon from the very first threw the weight of his authority against dactyloscopy, and even after he had been obliged by its growing importance to add it as a sub-classification of his own system he gave it but grudging support. Never for a moment would he admit that criminal files should be classified by finger-prints rather than measurements, and such was his influence that, even to-day, in France, there are no criminal files classified on a dactyloscopic basis. Indeed, Bertillon's opposition was so bitter and personal as to lead one to suspect that it was prompted by pique rather than judgment. To Sir Edward Henry he gave scant credit for his pioneer work in devising a classification method. "Henry did nothing new," he told me. "He merely copied the work of others." Indeed, on this one point he seemed to lack his customary poise. His repeated argument against dactyloscopy—or at least he used it as an argument—was that finger-prints represented an idea old even in Europe, to say nothing of the Orient. Shortly before he died he sent me, as a proof of his contention, a photograph of the title page of an English book on which the original owner had inscribed the date, "January 1st, 1824," followed by the print of his forefinger and the words "Thomas Bewick, his mark."

The results of the controversy between the Bertillon and finger-print systems of identification have been most unfortunate as far as police work is concerned. At first, most of the European cities, uncertain of the merits of the arguments and unwilling to lose the advantage of either method, at the cost of convenience and at great expense, adopted both. Thus, in London and the English provincial cities, in Berlin, Dresden, Munich, Hamburg, Vienna, Budapest, Rome, Amsterdam, and Rotterdam, an attempt was made to run the two systems side by side. But it was soon found that this procedure was adding enormously to the detail of office work. To maintain two elaborate files, classified on different bases, when one purported to answer the same purpose, was to load the department with a cumbersome routine which, particularly in the large city with its many prisoners to examine, soon became intolerable. It was inevitable, therefore, that one of the identification systems should be dropped, and it is not surprising that the finger-print method was almost invariably chosen as better fitted to survive. For the keynote of dactyloscopy is its simplicity. The only accessories needed to take finger-prints are a piece of tin and some printer's ink. Any person, whether educated or not, can perform the function with half an hour's practice. There is no possible margin of error, as finger-prints are absolute impressions taken from the body itself. Moreover, the ordinary system of classification is so simple as to facilitate ready search. As an example of the speed with which a search can be made under the Henry system of classification, my finger-prints were taken at Police Headquarters in Vienna, properly classified and filed with perhaps a hundred and fifty thousand others. An official who had not been present was called in and after taking my finger-prints afresh, was able, after three minutes' examination, to find my card in the files. This experiment was repeated for me in perhaps a dozen cities in Europe.

Finally, the finger-print method is advantageous in affording the police frequent opportunity to discover the perpetrator of a particular crime through marks which he leaves behind him. The finger-print system is, therefore, available for two purposes: first, *after* arrest, to identify a prisoner with a previous criminal record; second, to discover the author of a particular crime *before* any arrest is made, by comparison of finger-prints left behind him with finger-print cards on file at headquarters.

The inability of the Parisian police authorities to discover the author of the theft of *Mona Lisa* was due distinctly to Bertillon's method of classification. The thief, Perugia by name, had been in the hands of the Paris police on a previous occasion, when his finger-prints were taken. Finger-print impressions were left on the frame of the picture, but his record in Bertillon's file was not found because measurements, rather than finger-prints, constitute the primary classification. Under a pure dactyloscopic system, such as is employed in Rome, Vienna, Berlin, Munich, Dresden, London, or any of the provincial cities of England, the identity of the thief could have been established in half an hour.

In terms of actual results, the superiority of the finger-print system can readily be established. In England and Wales, for the year ending December 31st, 1911, the number of identifications made by the finger-print system was twenty times greater than the largest number effected in previous years by the anthropometric method. A

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* Journal of the Am. Inst. of Criminal Law and Criminology.

† Member of the New York City Bar. Author of "European Police Systems."

[1] The method used in Hamburg is described by Dr. Gustav Roscher, Police President of Hamburg, in his pamphlet, *Handbuch der Daktyloskopie fur Selbstunterricht bearbeitet.* Leipzig, 1905.

[2] In a paper read before the Congress of International Judicial Police, in 1914, Prof. R. A. Reiss, the well-known director of the Institute of Scientific Police of the University of Lausanne, urged the universal adoption of the Vucetich system of finger-print classification on the grounds of its simplicity. (*Premier Congres de Police judiciare internationale*, pp. 38ff.)

study of the identifications made by the anthropometric and finger-print systems in Scotland Yard shows similar results. Beginning with 1898, when the Bertillon system was in force, there were, for the year, 152 identifications; in 1899, 243; in 1900, 462; in 1901, 503, which included 93 identifications by the finger-print method. In 1902, when finger-prints had completely superseded the Bertillon system, the figures jumped to 1,032. In 1903, there were 2,062; in 1904, 2,611; in 1905, 2,853, since which time they have been steadily mounting as the number of cards on file at Scotland Yard has become annually larger. In 1912, 10,677 identifications were made, that is, 10,677 people were identified with previous criminal records. Statistics of a similar nature were obtained by the writer in Vienna, Dresden and other cities.

From the moment that the superiority of the finger-print system was understood there has never been a doubt that the Bertillon method was doomed. One by one, the cities that had been working with both systems have discarded the anthropometric method. Scotland Yard began it—in 1902—after an unsatisfactory experiment in combining the two systems. This example was immediately followed by the English provincial cities. Vienna dropped the Bertillon system in 1907 after five years' experiment with both. To-day the anthropometric method has been altogether discarded in Amsterdam, Rotterdam, Dresden, Munich, Budapest, Rome, and throughout Italy. In Berlin and Hamburg it is employed only for international or "roving" criminals who may have records in France. For all other purposes dactyloscopy is used. Thus, in 1912, the Hamburg Department measured 16 persons and took the finger-prints of 11,231. Indeed, at the last meeting of the International Police Congress (*Congres de Police judiciaire internationale*) held in Monaco two months before the war broke out, it was freely predicted that it would probably be only a few years before all criminal records in Europe would be classified on a dactyloscopic basis.

The controversy between finger-prints and measurements has worked an even greater chaos in American police circles than in those of Europe. Accustomed as we are to the notorious backwardness of our cities in adopting improvements which promote efficiency, it is nevertheless painful to contemplate the fact that at the very time that European cities were discarding their Bertillon cabinets as superfluous, many of our police departments were busy installing them. The writer has recently been in three cities of size and importance that are this year inaugurating a Bertillon system under the impression that it represents the latest word in the scientific detection of criminals! Indeed, as has been previously remarked, in some American cities an identification method seems to be looked upon by the police officials as a sort of charm or talisman, and in more than one department visited by the writer the boast was made that it had *two* identification systems. The heads of these so-called bureaus of identification gloried in their possessions, even when they did not know how to hold a pair of calipers or how to classify finger-prints!

Even in the more progressive American cities in the East there seems to be but little appreciation of the absurdity of maintaining side by side two distinct systems of identification. True, in New York city, the officials have made tentative plans for discarding the Bertillon method, but the fear that other cities will not follow the example and that New York will be cut off from her exchanges holds them back. On the Pacific Coast, where co-operation between departments is more effectively developed than in the East, a similar step has been planned and will undoubtedly be carried out as soon as practical arrangements can be made.

In the end, of course, Bertillon's ingenious system of identification will be discarded. As we here in America were backward in installing the new improvement, so, I suppose, we must be backward in letting the old incumbrance go. But about its going there can be no question. For many years it was undoubtedly of tremendous benefit to the police departments of all countries. But its foundamental to the simpler, surer system of dactyloscopy makes inevitable its final downfall.

Curious Cures

By Isabel F. Hapgood

An account of Dr. Fitzgerald's cures for assorted ailments by properly applied pressure has reminded me of certain curious remedies in use among the Russian peasants, which, probably, come under the same classification.

The man who collected a mass of folk-lore in this and other lines, and recorded it in a book now long out of print, was a physician and surgeon. Originally, he was an officer in the Navy—the Russian Navy seems to be a sort of preparatory school for artistic, musical and other entirely different professions—and died in 1872, aged seventy years. His duties as a military doctor took him into all quarters of Russia, as well as on foreign campaigns; and his interest in philology and national customs and beliefs, rendered him extremely keen in noting everything which he heard and saw. Many of the cures effected by unusual means he set down to superstition and imagination. Others, among them those I shall mention, he classed as "Sympathetic Remedies."

The most striking among them he tried in at least thirty cases, as he says, anyone can convince himself of its remarkable effectiveness. It may prove an inestimable boon to sufferers from malaria. Here it is:

An hour or more before an attack of the fever is expected, wrap the skin which lines the shell of a hen's egg (raw) round the little finger of the left hand (sometimes it is wrapped around the thumb with equally good effect), and in a short time the skin will adhere closely to the fingers and dry. The finger should be lightly wrapped in a bit of soft linen or cotton, to keep the egg-skin in place. The fever generally—not always—leaves the sufferer at once. At the time when the fever is due a pain (which is sometimes pretty sharp), makes its appearance in the finger, and begins to shoot up towards the elbow, occasionally darting to the very shoulder. The same thing happens with the second attack of fever, only the pain is much less acute, and on the third application the cure is finished.

This remedy has no effect on well people. Sometimes it does not take effect on fever patients—for no discernible cause—and then the chills and fever run their customary course, and there is no pain in the finger. Sometimes it acts in reverse order: the finger aches between the attacks and ceases to ache during the attacks, and does not prevent them. Occasionally the pain in the finger and elbow are so great that the patient cannot endure it, and tears off the egg-skin; in which case, the pain disappears and the fever returns. In rare cases, blood-blisters make their appearance on the finger, and even an abcess round the nail, like a whitlow. Our doctor says that he once saw a physician, who was in despair over the utter uselessness of quinine in a certain case, apply the egg-skin and effect a complete cure. But when the doctor himself had the fever, this remedy had not the slightest effect on him.

If anyone is choking or strangling, it is customary to place a slice of black bread—and the sour black rye bread of the peasants possesses solid weight—on the crown of the head; on the bridge of the sufferer's nose is pressed the index finger of the right hand.

Another remedy which our doctor records in the "sympathetic" category, although he makes no comment as to its actual results, is for an infantile disease known among the peasants by a name which, literally translated, means "dog's old age." (The dictionaries appear to be completely ignorant as to the disease.) The doctor suggests that it may arise from a withering of the spinal cord. A "thorough baking" is administered to the child, by placing it on the oven shovel, and rapidly thrusting it thrice into a heated oven, the oven being of the type which is heated by burning wood in it until only glowing coals are left, among which food is baked in pots, bread being baked after all these coals are swept out. Probably, the child is baked like bread.

Bandages applied to the hands and feet—or the arms and legs, since the words cover the entire length of the limb in Russian—and used by physicians in our doctor's day, act, he assumes, on the circulation of the blood, and by preventing the return of the blood to the heart, congestion of the internal organs (in a chill) is prevented, and the fever is broken. A tape, or nine strands of yarn, generally red, although the doctor doubts whether the color has anything to do with the efficiency of the cure, tied around a child's neck wards off scarlet fever. By inference he admits this remedy to be valid. I remember, in my childhood, seeing children with strings of red coral beads, or red strings on their necks, and this may have been an application of the remedy just mentioned.

Here is another which our doctor found himself unable to explain. "I knew a man, a 'sorcerer,'" he writes, "who used to distribute amulets against fever, after having uttered over them some incantation; and, although they did not help me and several other persons, yet, under my personal observation, they frequently put an instant end to an illness. At any rate, an obstinate fever never returned after the day when the mysterious amulet was hung around the neck of the sufferer. The contents of the amulet consisted of some unnamed root, which so the 'sorcerer' declared—had been pointed out to him by an exile to whom he had shown kindness on the road to Siberia." What impressed our doctor was this: After having tried the effect of amulets filled with that root on a number of patients, and been forced to consider the matter seriously, he arrived at the conclusion that there could be no explanation, save that the imagination of the patient cured him. Accordingly, he took another root—the first which came to hand—and began to hang amulets filled with it round the necks of his patients, pretending that he had received them from the "sorcerer" whose fame was well known. He did this with five patients, absolutely without result, and all of them most unwillingly and without the slightest faith, permitted him to repeat the experiment with an amulet of the genuine root. (As to this, of course, they were not informed.) The fever instantly left two of them. When he had fever he tried this remedy on himself, in vain. He received his amulet directly from the hands of the "sorcerer," and followed out all his instructions with the utmost strictness, just as he had done in the case of the egg-skin remedy, which had proved ineffectual in his case.

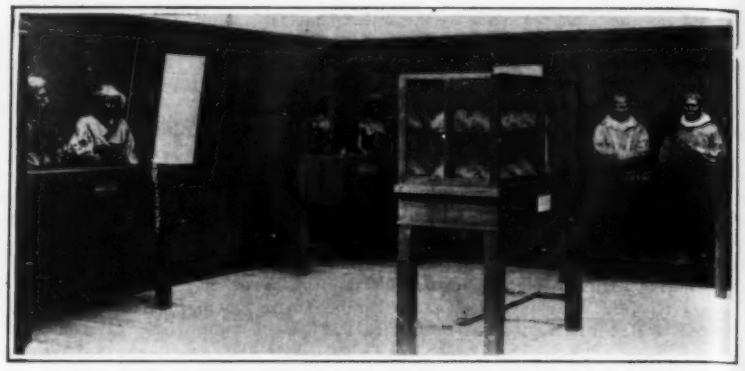
Family Resemblances*

Had the "Slingsby Case" been tried in less stirring times it certainly would have attracted a greater share of public attention, particularly from those who are interested in the inheritance of physical characters. Mr. Justice Bargrave Deane recognized a close degree of resemblance between the boy defendant and his father, Mr. Charles Slingsby, particularly in the case of the lower jaw; Sir George Frampton detected a likeness between the ears of the boy and his mother. On the day on which the learned judge gave his judgment a well-known anthropologist, an anatomist famous for his accuracy, descended in a lift with two men and a boy, all three of whom stared stolidly at the advertisements on the wall. One of the men was short and dark, the other fair and of medium height. The expert at once assigned the little boy as the son of the fair man from their close resemblance. As the lift gates swung open the boy took the dark man by the hand, called him "dad," while the fair man went his own separate way. In telling us his experience he adds: "Another case of mis-identification came under my notice on the evening of the same day. An intelligent and experienced lady called on a friend who took her up to the nursery to see the latest born. The visitor found two nurses and two babies, and exclaimed, 'Well, I need not ask which it is; this one is your image.' She then selected the wrong child." From such cases one must conclude that general resemblances may prove misleading. But it is otherwise with particular features, such as the Hapsburg lip. Medical men are well aware of such features; a nose, an eye, or an ear may have such a pronounced shape that a family identification may be made with certainty. Individuals with pronounced features are in the minority. There is no question that such features may be and are inherited. In many instances the characteristic form is not apparent in the young; it becomes fully developed after adolescence, and this is especially true in the case of the nose, and is also the case with the lower jaw. The boy defendant is 4 years of age; in the next 16 years his jaw will be remodelled over and over again to make room for the permanent molar teeth, the teeth which will replace his milk set, and to fit the growth of the upper jaw; it would be at maturity we should expect a real, not an apparent, resemblance of the paternal form of jaw to appear. The ear offers a more certain means of identification of likeness, but very few men have studied this complex structure so closely as to be in a position to offer an expert opinion as to degree of likeness. In the photographs which have been published of the parties in the Slingsby case an expert has little difficulty in recognizing what was apparently regarded as a striking feature of the "Slingsby" ear. The resemblance lies in the degree to which the hinder border of the ear is folded over so as to form a welt. It is well known that the folding of the ear margin is a result of retrogression; the more the border is folded over the greater is the degree of developmental retrogression. There is no folding of the border of the ear in the more primitive apes; in some of the higher apes, especially in the orang, there is a high degree of infolding, for the ear of the orang is more retrograde than that of most human races. A considerable degree of infolding of the ear is so common that an anthropologist would give it only a slight value in working out resemblances. Sir George Frampton's method of observation we do not know, but we must admit that sculptors have certainly a right to express an opinion. It was Thomas Woolner who drew Darwin's attention to the presence of a nodule on the welt of the human ear which the great evolutionist recognized as a remnant of the ancient pointed tip. That all parties concerned in the Slingsby case should show a trace of the ancient tip is not a matter for surprise; the ear is exceptional which shows no sign of this ancient mark.

* From *The Lancet*.

Based on electrical standards the average man produces about 2.5 kilowatt-hours power per day. This is consumed partly in muscular action, and partly in the production of heat in maintaining the body temperature against radiation. The human body has about the same heating effect upon its surroundings as a 16 candle-power carbon filament lamp.

Busts representing pre-historic man.



Adults of some of the races of today.

Man's Development Illustrated

Busts Depict the Earliest Known Human Beings

By Allen Henry Wright

To MANY of the thousands who visit the Panama-California Exposition in the city of San Diego there comes a thought of the audacity of such a small community, numbering less than one hundred thousand people, undertaking such a colossal task as the financing of a great fair and conducting it through an entire year. Then, too, after a tour of the hundreds of acres comprising the exposition grounds, there is left with one the deep-rooted impression that, so far as natural and scenic beauty are concerned, this can well accept the compliment bestowed by many, that it is the gem of all expositions.

For the student and those of a scientific turn of mind, however, there is much more than the mere scenic or beautiful to claim the attention. Almost from the first conception of this exposition it was planned that the history of man should be shown as never before, and to this end some of the foremost experts in the country lent their best energies.

In the Science of Man building there has been gathered a most wonderful collection of busts, charts, photographs and skeletons, which is said to be the most complete in the United States, if not in the world. The fortunate feature, too, about this great display is that it is to remain as the nucleus of a great museum in the southwestern city, a place to which will come scholars and students from all sections of the universe.

Dr. Edgar L. Hewett, director of the School of American Archeology, has been in charge of the gathering of this collection and of its display during the year. This museum was made possible by the co-operation of the National Museum of the United States, through Dr. Ales Hrdlicka, who is at the head of the department of physical anthropology.

Man, at the different stages of his evolution, is represented by ten artistic busts made by M. Mascre, under the direction of Prof. A. Rutot, connected with the Musee Nacional in Brussels, Belgium. These busts are as true to nature as it is possible to make them. The heads and faces are built up on the casts of the actual skeletal remains of each individual represented. In addition, the decorations and utensils shown with the busts are exact copies of the real objects found with the bones.

Thus, there is shown the Java man, estimated by some to have lived something like a half million years ago, followed by the busts of the Sussex man, the Heidelberg man, La Quina woman, the Neanderthal man, Galley Hill man, man of Spy, Grenelle man, Chapelle man, and the Cro-magnon man. About the walls are shown prints and diagrams of the localities where the various skeletal remains were discovered, and in glass cases there are to be seen casts from the originals, upon which the restorations were made by M. Mascre. A series of pictorial representations of early man, prepared by noted scientists and artists, are shown, side by side, with reproductions of the sketches which were made by ancient man himself, and which have been brought to light through explorations. In fact, in this display the student has the first chapter in the story of man.

Dr. Hewett is authority for the statement that the destruction of Louvain, in Belgium, at the opening of the present European war, resulted in the loss of the original skeletal remains upon which some of the busts in the series shown at San Diego were based. Not even in Belgium, however, was there a complete series such as is shown at the Panama-California Exposition, nor did any other continental museum possess the series in its entirety.

Passing over the intervening centuries, the different races of the present day are shown in accurate busts on display in another portion of the Science of Man building. To secure some of these, expeditions, headed by scientific men of prominence, were sent abroad to visit the various peoples in their native lands. Thus are shown busts of the Mongolians, the Eskimo, the African pygmy, the Negrito of the Philippine Islands, and other tribes and races. Then there are series of busts showing the development of the white, negro and Indian from infancy to extreme age all made from living models.

Long cases contain displays, through actual specimens, of the development of the various parts of the human anatomy from the first few weeks after conception through to the adult stage. Elsewhere will be seen exhibits of modern types of surgical instruments with which one can compare the primitive knives of obsidian and flint, shown in another case, with which the ancient races practised trephining. There are dozens of skulls, too, to show the exact way in which these cuts in the bone were made, these having been obtained during the exploration and excavation in ancient habitations.

The effects of disease upon the various bones of the body are shown by a series of skeletal portions, and these displays, together with many others in the Science of Man building, have served to make it a rendezvous for delegations of medical men and surgeons since the commencement of the exposition. It is claimed that not even the Army Medical Museum at Washington can afford as great a field of study for physicians and surgeons as is presented by the collection at San Diego, and, with the establishment of the permanent museum after the exposition closes, there is every promise that the city of the far Southwest will become a great center of study along these lines.

Mortar

In deciding what lime is the best for making a mortar, we must consider not only the local conditions, such as cost and experience of the laborer, but also three factors inherent in the lime itself: The volume of mortar which it will produce, the ease with which the mortar can be worked, and the strength developed by the mortar.

The quantity of mortar which a lime will produce varies very widely with the properties of the lime. Thus a pure, properly burned high-calcium lime will produce about 10 cubic feet of putty per barrel (200 pounds) of lime.[1]

The presence of any impurities (including magnesia) will decrease the yield of the paste. If the lime is either over-burned or under-burned, the yield will also be decreased. Moreover, the greater the volume of paste, the greater the volume of sand which can be added to it to make a mortar. This is not a direct relation, because the characteristic stickiness of a paste made from a pure high-calcium lime enables it to carry more sand in proportion to its volume than a leaner lime. At any rate, a high-calcium lime will yield the greatest volume of mortar, provided the mortar is properly prepared. If the lime is permitted to burn during hydration, the yield will be materially decreased; and the better the lime, the greater the danger of its burning. The elimination of this danger of burning is one reason why hydrated lime is growing in favor so rapidly. The yield of mortar is obviously a very important factor, because it determines how many pounds of lime will be required to lay a thousand brick.

[1] Emley, W. E., Crushing strength of lime mortar: Nat. Lime Mfrs. Assoc. Trans., 1913.

If we accept the definition of lime as given—that it shall contain not more than 5 per cent of impurities (not including magnesia)—there will be some difference in the working qualities of the putty produced. But when a large quantity of sand is added to make a mortar, any such differences will be hidden. The working quality of the mortar, therefore, need not be considered, provided the lime comes within the definition.

Mortar made from high-magnesian or "dolomitic" lime will eventually become about three times as strong as that made from a high-calcium lime. If a cubic foot of brickwork weighs 150 pounds, the load imposed on the mortar at the bottom of a wall, due only to the weight of the masonry, will be about 1 pound per square inch for every foot of height of the wall. Evidently, therefore, it is unnecessary to consider the strength of the mortar in most ordinary buildings. If, for any reason, a particularly strong mortar is desired, it is common practice to use Portland cement instead of lime, so that, in any event, the strength of a lime mortar should not be used as a criterion for judging the quality of lime.

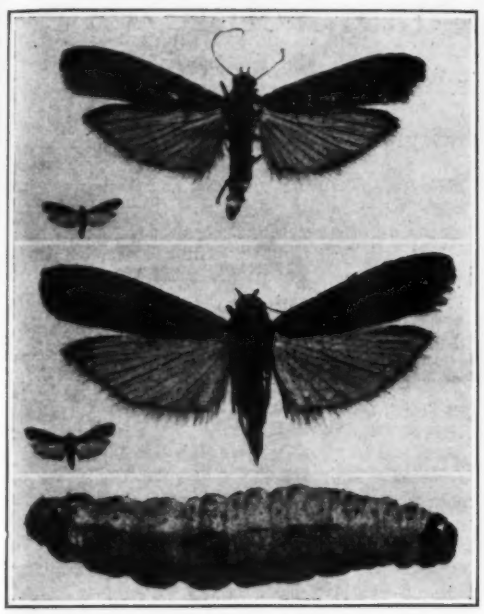
In conclusion, therefore, we find that if all other conditions are equal, pure, well-burned, high-calcium lime should be the best for making mortar, because it produces the greatest volume of mortar from a given weight of lime. The deciding factor in choosing a lime for mortar is the experience of the labor in the particular locality, for this will determine the yield of mortar obtained from any given lime.

Obvisouly, the same conclusions apply to lime used for the scratch or brown coat of plaster.—*Mineral Resources U. S., 1913, Part II, U. S. Geological Survey.*

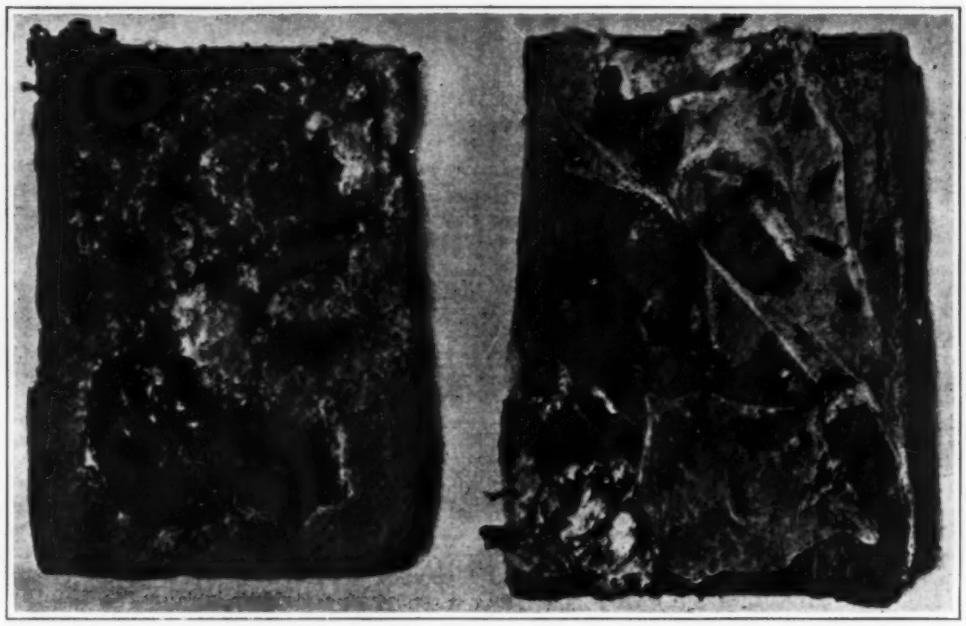
Diet Under War Conditions

THE European war has changed the supply of readily available foods, and brought about an enforced movement toward a partial vegetarian diet, in place of the more extensive use of meats, eggs, butter and wheat products. These changes, being the subject of governmental regulation and enforcement, place new restrictions on the dietary of the sick. It sounds strange to our ears to hear that patients are actually required to have a prescription or permit to enable them to procure wheat flour or wheat bread for the preparation of toast. The refinements of cookery, along with the modern milling of the various grains and the preparation of dried vegetables, are likely to eliminate in part the wide distinctions between animal and vegetable products. This is in harmony with the success of numerous sanatoriums conducted on vegetarian principles in matters of diet.

The various devices of the German army for furnishing suitable food to the troops in action are responsible for the unimpaired health of many persons. Fresh meats, potatoes and vegetables poorly cooked by the individual soldier under the stress of army conditions are certain to lead to dyspeptic diarrheas and irritations, the forerunners of infectious invasion. Experience in former wars abundantly verifies this statement, says *The Journal of the American Medical Association.* But the present field kitchens of the German army, the "Gulaschkanonen," as they have been fancifully called, have furnished foods that are cooked with great thoroughness, so that they are readily comminuted and then easily digested. The lessons of this diet service may well appeal to us.



The "Mediterranean moth," Ephestia Kühniella (male and female, natural size and enlarged).
This is the commonest of the three species of moths found in ration biscuits. Believed at first to have been indigenous to the Mediterranean. *Ephestia Kuhniella* has now been proved to have come originally from Central America into North America, whence it traveled to Europe in consignments of flour and grain.



Pests of the fighting-man's food: a ration biscuit infested by the Ephestia Kühniella moth.
This biscuit was found in an hermetically sealed tin during the investigation by a Natural History Museum Committee at the instance of the War Office. "The moths," it was discovered, "found opportunity to lay their eggs while the biscuits were cooling before packing." Preventive measures have been taken.

Pests of the fighting-man's food: a ration biscuit infested by the Corcyra Cephalonica moth.
The above illustration shows one of the biscuits found in an hermetically sealed tin, which was returned to England from an army station abroad as "uneatable." "Uneatable because riddled through and through with holes, tunnelled by fat white maggots, and covered with a nauseous-looking film of silky texture."

Flour Moths and Army Rations

Newly Discovered Enemies of the Human Race

WHEN it became possible to store food within hermetically sealed tins it was doubtless supposed that an inestimable boon had been conferred upon mankind in general, and upon our sailors and soldiers in particular; for viands could now be assured them in distant lands which would otherwise be unattainable. Substantially this supposition has been indeed justified. But from time to time this system has produced some very disagreeable surprises; occasionally, indeed, needing an inquiry by the coroner!

Till recently biscuits, at any rate, seemed secure from harm thus encased; one item at least in the rations of out fighting forces seemed removed from the category of the perishable. But time was to prove that this confidence was misplaced. During recent years, from distant outposts of our Empire, have come reports of consignments of biscuits discovered to be for the most part uneatable when the tin containing them was opened. Uneatable because riddled through and through with holes, tunneled by fat white maggots, and covered with a nauseous-looking film of silky texture. Even the "weevily" biscuit of other days was an appetizing morsel by comparison!

When these complaints became more and more numerous, the authorities of the British Museum of Natural History were asked by the War Office to hold an inquiry with a view, if possible, of devising remedial measures. This was undertaken by a member of the Staff, Mr. Hartley Durrant, in conjunction with Lieut.-Col. W.W.O. Beveridge, D.S.O., R.A.M.C. Sample tins, from South Africa, Ceylon, Gilbraltar, Malta, Mauritius, and the Sudan, were returned for their inspection, and the contents, when examined, might well have come from some witch's kitchen. A very cursory examination revealed a quite surprising variety of insect life, in the shape of moths and beetles, in every stage of development. Since each of these tins contained precisely similar samples of insects, though they came from regions remote from one another, it was obvious at the outset that all must have been infected at the same time and place—the biscuit factory at which they were made. The task now before the investigators was to identify the insects and discover their life-history, in order that measures might be taken to put an end to this very serious menace to the food-supply of our ships and garrisons. This done, it was necessary to discover at what stage in the process of manufacture infection took place.

No less than three different kinds of moths and two different species of beetles were found in the biscuits, while yet other species were found in the factories. It was possible that the eggs found entry with the flour during the process of making the biscuit. But this theory was soon found to be untenable by means of an elaborate experiment by which the internal temperature of the biscuit during its passage through the oven was taken. This temperature was found to be so high that any eggs which might have gained admission to the dough would most certainly be destroyed. After laborious research it was discovered that the moths found opportunity to lay their eggs while the biscuits were cooling, before packing. So soon as this fact was proved, preventive measures became possible.

Not the slightest blame could be attached to the manufacturers of these biscuits, for although they may have seen an occasional moth about their mills, they had no sort of reason to suppose that such harmless-looking creatures were capable of so much mischief. As to the beetles, they are so minute that their very existence was probably unknown to anyone in the mill. Moreover, theoretically, it was impossible for these creatures, even supposing they gained access to the biscuits, to survive in hermetically sealed tins.

But they did much more than this. They multiplied in a most amazing fashion. Egg, caterpillar, and winged moth succeeded one another in rapid and orderly succession in these closely packed, air-tight tins just as freely as in the open, well-aired mill. It seems incredible, but it is true.

The most troublesome of these moths is the species known as *Ephestia Kühniella*, which, till this inquiry, was supposed to have been indigenous to the Mediterranean, and to have made its way thence to America. Hence it was known as the "Mediterranean Moth." As a matter of fact, Mr. Durrant was able to prove it made its way originally from Central America into North America, whence it traveled to Europe in consignments of flour and grain.

It would seem that these attacks on our Army biscuits by insect pests have been going on, more or less continuously, for more than a hundred years. This much may be gathered from a sergeant in the Gordon Highlanders, who, writing of events in February, 1801, at Marmorice Bay—where the British forces concentrated prior to sailing for Alexandria—remarks: "Some vessels were despatched to . . . Smyrna and Aleppo for bread, which was furnished us by the Turks. . . . We were glad to get this, as our biscuits were full of worms; many of our men *could only eat them in the dark*"

A case devoted to the illustration of these infected biscuits, and the insects which infest them, has been placed in the Central Hall of the Natural History Museum, by special request of the War Office.—W. P. Pycraft in the *Illustrated War News*.

* *Illustrated London News.*

Films May Help in the Selection of an Occupation

AMONG the various uses of the cinematographic film, increasing prominence and a wider field have been given to its possibilities for pedagogic purposes. In school instruction films will play an important role in the not distant future, especially in colleges. In fact, "School cinematography" has become a new means for instruction which will prove indispensable.

In colleges, industrial and trade schools the film may become of value in helping to solve the important question of the choice of an occupation or profession. For some time, efforts have been made to arouse the interest of school-children, above all those about to leave school, in the learning of a trade. Thus, for instance, the Central Board for the Accommodation of Apprentices of Berlin considers it a part of the education of children to prepare them for a trade.

In the discussion of an occupation or profession the main thing above all is to interest the child about to leave school in an occupation corresponding to his capacities and predilections. A wrong selection avenges itself frequently for a whole life. An unnecessary coercion, as, for example, to pursue scientific study, has brought to grief many an existence, frustrating many a talent and qualification.

But in the question of the choice of an occupation the film will be helpful.

The selection of the proper occupation will be made easier for young men, as well as for their parents, by making them acquainted with the different trades, which can be done by allowing a glance at the operations of the different trades represented by cinematography in a life-like, natural manner.

There is no other way of accomplishing the desired result, except by personal visits to trade shops, which is largely out of the question.

It is worthy of note that the "Central Station for Scientific and Instructional Cinematography" has interested itself in this branch of instruction and has prepared a series of moving pictures of trade shops. In this way, one can see the making of a book cover, a wagon, a forged gate, etc., and there is thus obtained an insight into the bookbinder's trade, the wheelwright's, farrier's, etc. The first presentation of these films in Berlin not long ago was technically perfect, no less than with regard to the choice of subjects, proving that such instruction by pictures deserves the greatest attention from parents, instructors and apprentices. The mentioned "Central Board" has thus attempted cinematographic instruction for the purpose of aiding in the choice of occupation, and it may be considered as entirely successful.

Toward elevating and developing the trades the presentation of films will certainly contribute their share, since they are eminently well suited to excite the appropriate interest. In public moving picture theaters these films should be shown to a greater extent than they have been. They would remove many a prejudice and correct many a disparaging opinion current in the great public regarding the several trades, and thus insure to the trades their due consideration. Even while the general opinion of the trades and of artisans is being raised, will the trades as a whole experience an encouragement, and the selection of an occupation be favorably influenced.—*From Prometheus.*

A Gas Engine Economy

A SPEAKER before the English Ceramic Society recently stated that 60 per cent of the total steam generated in the English pottery establishments went to heating the hot floors, drying racks, etc., and he suggests that if gas engines were adopted the heat usually lost in the exhaust might be recovered and used for the above purposes, either by drawing the exhaust gases directly through the heating coils, or the floors, or by utilizing them in an exhaust boiler.

Research and Progress in American Manufacture*

What the Investigator Has Done and Can Do for Industries

By Dr. Raymond F. Bacon of the Mellon Institute of the University of Pittsburg

WHILE it is tacitly accepted by modern chemical industrialists that their manufacturing operations must be based upon research if they are to meet with success, it is not generally recognized that scientific research work conducted in the laboratory is the soul of industrial prosperity. However, much evidence of a convincing nature may be cited to show that research and progress are synonymous as applied to manufacturing.

The national government, endowed institutions, and industrial establishments have advanced research on a business basis, but the public has not been taught to value it. This may be attributed to three causes: (1) The work of the researcher, and especially the industrial researcher, is carried on in a quiet manner and is frequently of a secret nature; (2) the development of manufacturing is a very gradual evolution, each step of which is made possible by work which has been done before, and each step in advance of which is principally a natural evolution of what has preceded it; and (3) science has not received the proper treatment in magazines and newspapers, and consequently the readers thereof are not acquainted with the many ways in which science is co-operating with industry. That the calamity of the European conflict has served to direct the attention of the American public to the dependence of all of our industries on chemistry, is purely incidental. The evolution of chemistry, and with it industrial research, has been proceeding rapidly during the past two decades, and has left its mark on the whole industrial development. American industries, whether chemical or metallurgical, are firmly established, rapidly growing realities, and the public should be acquainted with the principal factor involved in this growth.

Statisticians inform us that the progress of manufacturing in recent years is recorded in the patent literature. The technologist knows that this is incorrect, for such literature generally indicates those appliances and processes which cannot be kept secret. Nor can the progress of industry be traced by the imports, as stated for the chemical industry by Herstein.[1] A more definite relation exists between research and progress in manufacturing, although desirable statistics are wanting. Even though we cannot assert that the broadening of domestic production has been proportional to research, it may be said that the industrial profitableness of to-day is derived from efficiency in production, and efficiency has resulted from research.

THE INDUSTRIAL ACTIVITY OF THE CHEMIST.

If it is conceded that chemistry is the intelligence department of industry,[2] one may therefore conclude that the measure of the influence of the profession of the chemist upon the industrial development of our country constitutes *per se* an index of the value of research to manufacturing. I have pointed out in another place[3] that the measure of a country's appreciation of the value of chemistry in its material development and the extent to which it utilizes this science in its industries, generally measure quite accurately the industrial progress and prosperity of that country.

As mentioned, the public has been left to its own resources to determine the function of that industrial scout, the chemist. This condition has been briefly explained by one chemist: "Our public work is obscured by impenetrable technical detail and our industrial achievements are cut off from public view by high factory walls." A large percentage of the 10,000 chemists of the United States do labor under cover, yet these 10,000 men—about 25 per cent of whom are engaged in industrial research, the others in control work—are actively occupied in manufactures which affect over 1,000,000 wage earners and produce over $5,000,000,000 worth of products. As Hesse[4] has quite convincingly demonstrated, in the case of thirty-one American industries, the chemists employed therein directly affect 24.6 per cent of our manufacture values and 20.2 per cent of our values added by manufacture. They are constantly engaged in the development of processes and in refining methods of control or of manufacture.

THE EVALUATION OF INDUSTRIAL RESEARCH.

Many industrialists are even now certain that research will not pay. Some regard their technology as an hereditary art. Some have favorable raw material conditions or a large demand for their products, and are therefore disinclined to invest a very small portion of their earnings in a reserve of knowledge. Others have prospered because of high tariff, notwithstanding short-sighted management. But most of our industries are built upon stronger foundations. It is plain that the use of natural laws offers a more stable basis upon which to erect a manufacture and a more uniform source of profit than any structure built upon artificial conditions created by legislation. Moreover, the quality and value of a product are based upon the application of correct principles in its conception, preparation, and use, and the correct principles can only result from scientific research. Ample support to this contention is to be found in the manufacturing operations of to-day.

THE METALLURGICAL INDUSTRIES.

Turning first to metallurgy, one finds that the metals industrialists first called the service of research to their aid about 1885, to assist both in the perfecting of processes and the necessary mechanical equipment. In consequence whereof, zinc smelters eventually obtained the high extraction results, the low fuel consumption (by regenerative gas-firing), and the reduction of labor which characterize their art to-day, and have made much progress toward the solution of their two great problems, the concentration of the ore and the treatment of flotation concentrate. Likewise, the scientist showed the copper industrialist how to make his metallurgical operations so constant that in the manufacture of refined copper the valuations of the product do not differ by more than $1 in every $50,000 worth of product; and research is now making promising progress in the development of flotation processes, in leaching of ores, in electrolytic deposition, and in electrolytic refining (especially in the treatment of anode slimes and in the recovery of by-products).

For 25 years the value of research chemists in improving mining operations and in concentrating, roasting and smelting developments, has been appreciated, and each year a greater amount of money is expended by metallurgical companies for research than is in proportion to the increase in the production of ores. Those who desire to engage in mining are no longer deterred therefrom by the prospect of encountering a difficult metallurgical problem. The rapid progress in metallurgy during especially the last decade has inspired an abiding confidence and has aided more than all other factors combined in the extension of the mining industry. One prominent engineer has said:[5] "If I can only find the mine, I have little doubt of being able to develop a suitable treatment process." But even in the absence of the discovery of new mining districts, operators are seeking for neglected opportunities in the dumps and mines of abandoned districts,[6] confident that the metallurgical difficulties of the past can be overcome by research.

THE MANUFACTURE OF IRON AND STEEL.

To the valuable properties of the many alloys of iron now manufactured, from carbon steel to the complex alloy known as high-speed tool steel, which contains no less than five different elements apart from the iron itself, is to be attributed the great progress which has been made, whether in the arts of peace or in war. There is one simple concrete instance—the modern automobile. Eliminate the alloy steels used in its construction, and it could no longer be produced. The combination of lightness and strength necessary in such modern products is only made possible by the use of special alloy steels.

While the progress made in alloy steels since Hadfield's first researches in 1862 and onward has been wonderful, indeed, the field for research is still an immense one, full of difficulties, disputed points, and important problems. It is true that there may not be at the present time room for such abnormal discoveries in ferrous metallurgy as in the past, but investigators are quietly and steadily augmenting our knowledge of iron and its alloys, and the value of such research work is generally recognized.

It remains to mention in this connection that the science of metallography, which has so materially aided the progress of metallurgy, has been developed by the assistance of that keen weapon of the physical chemist, the phase rule.

THE PETROLEUM INDUSTRY.

Marked success has attended scientific progress in the refining of petroleum. Research has worked out processes for the dehydration and desulphurization of crude oils and for the depolymerization of heavy oils (especially the conversion of gas oils into motor fuel), and large refiners are now applying physico-chemical principles to the refining of oils, as instanced in tower stills (fractional condensation), the automatic control of temperatures during distillation and production of paraffin wax, and decolorization of products by fuller's earth or bone-black. The employment of steam in the production of lubricating oils, the process of continuous distillation, and the methods for chemically treating the products, are the results of research. More recent achievements in petroleum research are the production of drying oils from neutral oils and the synthetic preparation of fatty acids from crude oil. Then, too, it may be predicted that a simple, direct process for obtaining the butadiene hydrocarbons from petroleum will soon be found, and thus a good route to synthetic rubber will be opened up.

In the related asphalt industry, chemical research showed how asphaltoid bodies of much commercial importance might be prepared by the oxidation of petroleum, and the chemist has also given his aid in the preparation of suitable fluxes, in evolving a rational method of pavement construction, and in improving asphalt surfaces.

THE SULPHURIC ACID INDUSTRY.

The manufactures of sulphuric acid and soda, the basis of all the other chemical industries, only attained to their full vigor after the various processes involved had been explained by research and after the most favorable conditions had been worked out. At the present time sulphuric acid is so extensively used that it is regarded as the gage of the activity of the nation in chemical manufactures.

The first important practical improvement was made in the manufacture of sulphuric acid in this country so early as 1814, when platinum stills were introduced for the concentration of the acid. Later the process was made continuous, and many improvements rapidly followed. Then the contact process, the development of the great industrial researcher, Winkler, was introduced and improved. And finally we have the industrially important process for obtaining sulphuric acid from smelter gases. In 1913, about 22 per cent of the total sulphuric acid produced in the United States was recovered from the gases from copper and zinc smelters.

THE MANUFACTURE OF NITRIC ACID.

The manufacture of nitric acid, first begun in this country about 1834, was advanced by the form of apparatus devised by the chemist, Hart and received its first great impetus about 1862, when the commercial manufacture of nitroglycerin began. It has later derived much nourishment from the great celluloid and nitrocellulose industries, also indissolubly linked with the work of the research chemist. Nitroglycerin, dynamite, gun-cotton, pyroxylin varnishes, plastics and powders, photographic films, and artificial silk, are all the result of a line of concerted research activity.

In this connection, it is appropriate to refer to an accomplishment of electrochemical research, which has demonstrably multiplied the food-supply sources of all civilized countries—the process, laboriously wrought, of effecting the combination of the nitrogen and oxygen of the air, and thus producing nitric acid and its salts. The great adaptability of certain parts of our country to electrochemical manufacturing, on account of the water-power available, may soon introduce this air-fertilizer industry.

THE ELECTROCHEMICAL INDUSTRIES.

The application of electrical energy has greatly facilitated the work of the industrial researcher, who has thus been enabled to perform easily some very difficult operations, and in some cases to accomplish results which would be otherwise impossible.

The electrolytic alkali industry is barely twenty-five years old, yet it has largely superseded the older chemi-

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* Address delivered at the National Exposition of Chemical Industries, Grand Central Palace, New York, September 25th, 1915.

[1] J. Ind. Eng. Chem., 4 (1912), 328. Cf. Grosvenor, *ibid.*, 5 (1913), 686.

[2] This statement should not give rise to an impression that the contention is that the industrialist relies *absolutely* upon the chemist. The technical demands made by modern manufacturers are extensive and exacting, and sole reliance upon the chemist would be oftentimes fatal to the realization of success. The aid of other industrial specialists must always be called in during the course of development.

[3] Science, 40 (1914), 871-81.

[4] J. Ind. Eng. Chem., 7 (1915), 294.

[5] Met. Chem. Eng., 13 (1915), 522.

[6] For a striking example of this metallurgical revival, see Parmelee's account of the cyanidation of low-grade sulphide ores in Colorado, *ibid.*, 477.

cal process for the production of caustic soda from common salt. Chlorates and perchlorates are now made by electrolysis. Metallic sodium may be produced at one fourth the cost of making it by any chemical method. Magnesium cannot be practically manufactured by other than the electrolytic process. Aluminium can not be produced for less than $1 per pound by purely chemical methods; but electro-chemistry enables the manufacturers to sell it at one fourth this cost. This metal is one of the most important next to iron and steel, and 72,379,000 pounds of it were produced by one American company in 1913. Copper, lead, silver and gold are now refined by electrolysis; in fact, the total electrolytic production of copper amounted to 1,629,930,359 pounds in 1913.

Among other commercial products of importance, artificial graphite, carborundum, alundum, silicon, calcium carbide, cyanamide, titanium, boron, phosphorus, and carbon disulphide, are all made electrochemically by processes which were worked out by research. Electric furnace pig-iron and electric steel are now made and sold at a profit; the development of these manufactures is calling for the best efforts of electrometallurgical research, and it is reported that the United States Steel Corporation has expended over $800,000 in investigations on the electrothermic production of steel.

THE GLASS INDUSTRY.

The production of glass, which reached a high state of development in olden times through pure empiricism, has greatly benefited by chemical research, although the contributions of the chemist to this industry are obscured by the epoch-making developments in methods of mechanical manipulation (working and handling the molten glass) effected by another industrial researcher, the experimental mechanical engineer. As I have indicated in another place, the glass industrialist has many problems,[7] but his troubles will vanish when the chemical constitution of glass is definitely determined, when the ideal non-contaminating pot or tank is found, and when heat is better utilized.[8]

THE FERTILIZER INDUSTRY.

Research has played a most important part in the development of the various industries which are dependent upon the products of the soil. No service has, however, been of such constructive value to agriculture as the chemical research which has eventuated in the great fertilizer industry of to-day.

The necessity of the fertilizer industry was indicated by Justus von Liebig, who, in 1840, after exhaustive investigations, enunciated the foundation principles of modern agricultural chemistry; and the conclusion of this savant, that one must restore to the soil that which the removal of the crop has withdrawn, if one would prevent its exhaustion, is the basis of agricultural practice to-day. The production of superphosphate followed Liebig's researches, in 1842, since which time the process of manufacture has been gradually developed until the insoluble phosphoric acid is only a fraction of one per cent and we have a double superphosphate containing from 45 to 50 per cent of available phosphoric acid. Research has also solved the recovery of nitrogen from waste gases; it has made material progress toward converting the nitrogen of the air into forms suitable for plant nutrition; and has shown that it is possible to convert many waste products into fertilizer materials. These are merely some of the accomplishments of research[9] for an industry which is the backbone of agriculture, the foundation of industry.

I beg to remind you in this place of a potent factor in our agricultural, and hence industrial, growth—the experiment stations established by the Government in the various States: all of these stations are in charge of efficient specialists, and many intricate problems of national importance have been solved.

THE COTTONSEED OIL INDUSTRY.

In the great cottonseed oil industry—4,767,800 tons of seed were crushed in 1913—Wesson has reported[10] that, while the chemist has worked to improve the manufacturing side of the industry, he has been the means of putting something like $125,000,000 every year in the hands of the farmers. Among other things, chemical research has rendered service to this industry by putting the refining of the crude oil on a more rational basis, by preventing losses in manufacture, and by devising the hydrogenation process, whereby wholesome edible fats of the consistency of butter are now being produced from our cheapest vegetable oil.

THE CORN PRODUCTS INDUSTRY.

In a notable address on "Efficiency in Chemical Industries," T. B. Wagner has shown that the corn products industry furnishes one of the most striking examples of what efficiency has done for the development of a chemical industry within a comparatively brief space of time. To quote Wagner:[11] "We pay to-day for our raw material—corn—three times as much as did our predecessors, and yet we sell our products in the markets of the world at one third of their price."

Research has been the making of the industry of corn products. According to President Bedford of the Corn Products Refining Company,[12] "while the chemist was most active from the very beginning in developing the process for making glucose and grape sugar and in steadily improving their quality, he also demonstrated his value to the industry by developing new staple products such as starches for culinary and technical purposes, of dextrins and gums and various sugars, which in point of purity rival cane and beet sugar. These products are now manufactured in this country in very large quantities and are being shipped to all parts of the world. A brief reference to statistics will illustrate the effect of such work. The corn manufactured into corn products in this country amounts to 50,000,000 bushels per year. It is converted into 800,000,000 pounds of corn syrup, 600,000,000 pounds of starch, 230,000,000 pounds of corn sugar, 625,000,000 pounds of gluten feed, 75,000,000 pounds of oil and 90,000,000 pounds of oil cake."

OTHER INDUSTRIES.

The manufactures of pulp and paper, sugar, textiles, leather, and cement are other industries based largely on chemical processes. They have therefore been mainly dependent upon research for their advancement.

There has been very little research activity in the destructive distillation of wood industry. As a consequence thereof, this branch of manufacture has been undergoing a trying ordeal, and ones engaged therein must soon avail themselves of chemistry if the many problems are to be solved. A more rational utilization of wood-tar is essential for the future of this industry, and new uses for methyl alcohol and acetate of lime are anxiously desired. Only research can render these services by creating the needed markets.

Another manufacture which has taken little advantage of scientific research is the earthenware industry. While the technology of pottery is comparatively simple, potters could profit immensely by the extension of fostered research and ceramic chemists would in turn greatly benefit by the opportunities thus offered. The American Ceramic Society has been active in endeavoring to arouse the interest of industrialists in this field in the value of research; but the art of pottery presents a more ancient alliance between art and utility than any other branch of manufacture, and the potter is proud of his lineage and his inherited empiricism.

At the present time a number of American plants are engaged in the manufacture of products which enter into the making of war supplies. Since these plants may, at the conclusion of hostilities, be converted into chemical manufactories, a number of fields of industrial research will probably be opened up. With the profits which shall have accrued from ammunition production, there will be no lack of capital in certain quarters for building up a synthetic-organic chemical industry.

INDUSTRIAL RESEARCH METHODS.

It must not be assumed that because an industry has been advantaged by research, the manufacturers engaged therein usually make a practice of maintaining research laboratories. As a matter of fact, in the United States, probably not more than one hundred and fifty manufacturing establishments employ research chemists, although at least ten companies are spending over $100,000 per year in research.

A number of our industrialists hold that they are able to purchase improvements in processes and plant without the risk of experimental expenses. This policy is practised to quite a large extent, but is open to the objection that the risk of not finding new developments or of not having an opportunity to purchase them, may result in losses many times greater than the expense of supporting research laboratories.

Still other manufacturers either have their researches conducted in universities or scientific institutes, or combine with others for the support of investigations on problems of common interest—that is, the problems are attacked outside of the plants. Co-operation is now being brought about in a measure by the organizations represented in different industries. An unfortunately frequent difficulty encountered in the employment of research chemists, or in the establishment of a research laboratory, is that many manufacturers do not appear to grasp the need or importance of such work, or know how to treat the men in charge so as to secure the best results. The industrialist may not even fully understand just what is the cause of his manufacturing losses or to whom to turn for aid. If he eventually engages a chemist, he is sometimes likely to regard him as a sort of master of mysteries who should be able to accomplish wonders, and, if he cannot see definite results in the course of a few months, is occasionally apt to consider the investment a bad one and to regard research chemists as a class, as a useless lot. It has not been unusual for the chemist to be told to remain in his laboratory, and not to go in or about the works, and he must also face the natural opposition of workmen to any innovations, and reckon with the jealousies of foremen and of various officials.

From the standpoint of the manufacturer, one decided advantage of the policy of having all problems worked out within the plant is that the results secured are not divulged, but are stored away in the laboratory archives and become part of the assets and working capital of the corporation which has paid for them; and it is usually not until patent applications are filed that this knowledge, generally only partially and imperfectly, becomes publicly known. When it is not deemed necessary to take out patents, such knowledge is often permanently buried.

In this matter of the dissemination of knowledge concerning chemical practice, it must be evident to all that there is but little co-operation between the manufacturers and the universities. Chemical manufacturers have been quite naturally opposed to publishing any discoveries made in their plants, since "knowledge is power" in manufacturing as elsewhere, and new knowledge gained in the laboratories of the company may often very properly be regarded as among the most valuable assets of the firm. The universities and the scientific societies, on the other hand, exist for the diffusion of knowledge, and from their standpoint the great disadvantage of the above policy is this concealment of knowledge, for it results in a serious retardation of the general growth and development of science in its broader aspects, and renders it much more difficult for the universities to train men properly for such industries, since all text-books and general knowledge available would in all probability be far behind the actual manufacturing practice. Fortunately, the policy of industrial secrecy is becoming more generally regarded in the light of reason, and there is a growing inclination among manufacturers to disclose the details of investigations, which, according to tradition, would be carefully guarded. These manufacturers appreciate the facts that public interest in chemical achievements is stimulating to further fruitful research, that helpful suggestions and information may come from other investigators upon the publication of any results, and that the exchange of knowledge prevents many costly repetitions.

INDUSTRIAL FELLOWSHIPS.

If the manufacturer elects to refer his problem to the university or technical school, such reference may take the form of an industrial fellowship, and much has been and may be said in favor of these fellowships. They allow the donor to keep secret for three years the results secured, after which they may be published. They also secure to him patent rights. They give highly specialized training to properly qualified men, and often secure for them permanent positions and shares in the profits of their discoveries. It should be obvious at the outset that a fellowship of this character can be successful only when there are close confidential relations obtaining between the manufacturer and the officer in charge of the research; for no such co-operation can be really effective unless based upon a thorough mutual familiarity with the conditions and an abiding faith in the integrity and sincerity of purpose of each other. It is likely to prove a poor investment for a manufacturer to seek the aid of an investigator if he is unwilling to take such expert into his confidence and to familiarize him with all the local and other factors which enter into the problem from a manufacturing standpoint.

According to the system of industrial research in operation at the Mellon Institute of Industrial Research of the University of Pittsburgh, a manufacturer having a problem requiring solution may become the donor of a fellowship: said manufacturer provides the salary of the fellow selected to conduct the investigation desired, the institute furnishing such facilities as are necessary for the conduct of the work.[13]

Even at the risk of appearing to secure a gratuitous advertisement for the Mellon Institute—however, this institution is not in any sense of the word of a commercial nature—I beg to present the following table showing the growth of the system of industrial research in operation therein, a record of the growing appreciation by American industrialists of a form of service to manufacturing, which is characterized by scientists as

[7] J. Ind. Eng. Chem., 7 (1915), 535

[8] Only 5 per cent is actually utilized in making glass.

[9] It may be noted here that not only was Baltimore the principal market for fertilizers until some time after the civil war, but it was also the center of chemical fertilizer research from the beginning of the artificial fertilizer industry in 1850, when spent bone-black from the suger refineries was first utilized and superphosphate first manufactured, until 1855, when Peruvian guano became so popular.

[10] J. Ind. Eng. Chem., 7 (1915), 277.

[11] Trans. Am. Inst. Chem. Eng., 6 (1913), 1.

[12] J. Ind. Eng. Chem., 7 (1915), 275.

[13] On the object and work of the Mellon Institute, see Bacon, J. Ind. Eng. Chem., 7 (1915), 343.

being both "eminently practical"[24] and "admirable."[25]

Academic Year.	Number of Fellowships in Operation.	Number of Fellows.	Amounts Subscribed for the Maintenance of Fellowships.
1911–12.....	11	23	$39,700
1912–13.....	16	30	53,500
1913–14.....	15	29	59,100
1914–15.....	24	42	74,350

At the present time, thirty fellowships are in operation, and over $175,000 is being expended annually for salaries and maintenance.

RESEARCH AND THE NATIONAL WELFARE.

One of the alleviating circumstances in the disaster of the European war is the fact that it forces on the attention of all the place that science holds in national and international affairs. As Cattell observes, science does not necessarily or at once make us moral or wise, although its general influence is in this direction; for human nature cannot be greatly altered by a change in the environment effective for a short period and on some individuals. But when the new conditions become general and individuals are favored who fit into them, so that an altered race is preserved by natural selection, science will make our morality and enforce its observance.

Those who fail to understand the argument that science will ultimately control human conduct must be convinced by the argument of accomplished fact that science is essential to national efficiency. Germany adjusts the nation to be self-supporting and self-sufficient, because it has a better organization of science than the other nations. That nation did not spend so much per capita on its army and navy as Great Britain or France, but it spent more on science and regarded science more highly."[26] It has been stated that the British government employs seventeen chemists, the German government about one thousand. It is said with much show of reason that Germany has developed an efficient military machine by subordinating the individual to discipline from above. It is not less true that the German university has been one of the most anarchic of institutions, both students and professors having had freedom greater than they have in American universities, and at the present moment Germany owes more to its universities as they have been conducted in the past than to its army as [illegible]now organized.

A complicated machine is not useful in order to meet an emergency, but rather the scientific attitude and the scientific training which can react to the situation. A superdreadnought built at a cost of, say, $15,000,000 may be an asset or a burden. An equal sum spent in selecting and educating 3,000 scientific men would nearly double the number of men in the country competent to advance science. The dreadnought is a continual expense, it depreciates at the rate of a million dollars a year, its existence tends to exert an influence toward a war of aggression. The three thousand scientific men would add to the wealth of the country in peace, to its strength in a war of defense. If the number of men engaged in scientific research and in the application of science could be doubled, the gain would be incalculable.

The formation of the Naval Advisory Board by Secretary Daniels is distinctly an official recognition of the accomplishments of our scientists. This board is to advise the Secretary of the Navy regarding new inventions and possible methods of improving the defensive and offensive qualities of the American Navy, and the chemical profession is officially represented by two distinguished researchers, Drs. L. H. Baekeland and W. R. Whitney.

Deaf-Mutism Produced by Shock

A REMARKABLE feature of the present war is the number of cases in which the sense of hearing is injured, not by direct destruction of the ear, but by the shock produced by heavy firing. A French scientist, M. Marage, who was recently charged by the Minister of War with the auditive re-education of wounded soldiers who suffered some degree of deafness in consequence of such traumatisms, has just made a very valuable report upon the subject before the Academy of Sciences. This report is of special importance because the study of such traumatisms, which sometimes result not only in complete deafness, but in deaf-mutism, has led him to formulate a hypothesis in regard to cases of congenital deaf-mutism which cannot be explained by heredity or disease.

He holds that such cases result in all probability from a shock to the brain of the fœtus due to an accidental fall of the mother during pregnancy. Even though the woman herself may not suffer from the fall or consider it serious, the concussion would be transmitted with great violence, by means of the surrounding fluid, to the child's brain, as yet unprotected by a bony skull.

M. Marage observes that instances of traumatic deafness are well known in times of peace, being found in officers of the schools for gunnery. In such cases the deafness is directly due to the noise or concussion of air produced by the firing of large caliber guns. There is rarely a tearing of the tympanum, and properly cared for at once, these cases, which may all be referred to a traumatism of the middle ear, are quickly cured.

But numerous cases observed in the present war are very different indeed, and the report considers them from three points of view—the causes, the nature of the lesions, and the degree of auditive acuity subsequently observed.

1. *Causes.*—These are of two kinds: *a*, a fragment of shell, a bullet, or a shrapnel strikes the skull at a greater or lesser distance from the ear (cases in which the ear is more or less directly destroyed are not here considered), without causing direct lesions of the brain by the pressure of a sunken bit of bone. The symptoms here include more or less generalized pains in the head, buzzing or ringing of the ear, as light loss of memory, decrease of audition, and a slight trembling of the limbs. These are similar to the symptoms which follow a more or less violent blow on the head. *b*. A large caliber shell (1 to 4 meters; 3 feet to 13 feet.) Here there is no apparent wound, but the same symptoms are found as before, only in a higher degree. Thus there may be loss of consciousness lasting from several hours to six days, very violent headache in the frontal region, persisting for several months, a loud buzzing or ringing which gradually disappears, complete loss of memory, absolute or nearly absolute loss of hearing (sometimes the patient hears but does not understand), very pronounced trembling, especially of the arms, and finally, even complete deaf-mutism at times. These symptoms of course indicate very grave cerebral disturbance.

2. *Lesions.*—There are two sorts of lesions: *a*. Of the middle ear: These comprise a pressure of bone due to depression of the skull, laceration, hemorrhage of tympanum, and, often as a result, suppurative middle ear otitis, which may heal of itself in three weeks, or may be prolonged for months, becoming chronic otorrhea (*otorrhee classique*). *b*. Here the lesions are not apparent, and these are the gravest cases, for they are accompanied by the severest symptoms. It may be said that we have in these cases a labyrinthine or cerebral disturbance.

3. *Auditive acuity.*—When one measures auditive acuity by means of the synthetic vowels (*voyelles*), one obtains two sorts of curves: the first kind is characteristic of lesions of the middle ear, the second are those found in deaf-mutism. Sometimes low notes are heard better than high ones, and sometimes there are gaps in the audition. The latter diagnosis is very important, for it possibly permits the elucidation of a point which has remained obscure in the etiology of deaf-mutism.

We are, in fact, still ignorant of why certain children are born deaf-mute. Consanguinity cannot explain, for cases are known where father and mother were members of different nations. Heredity does not seem to offer an explanation, for parents who are deaf-mutes may have normal children. Arrested development of certain cerebral centers is a logical hypothesis, but it becomes necessary to explain such arrestation.

The cases of deaf-mutism observed resulting from explosions of large caliber shells suggest the offering of the following explanation: During gestation a mother falls or has a shock which does not seem serious; this shock is transmitted integrally by the medium of the amniotic fluid to the whole surface of the brain of the fœtus, which is not yet protected by a bony skull; there follows a cerebral disturbance, slighter, indeed, than that due to a projectile, but which, acting on a far more sensitive organ, produces analogous lesions and effects. But it often happens that when the cause of deaf-mutism in an infant is being sought for, one finds the mother had a fall during gestation.

Resumé.—The present war presents cases of lesions of auditory centers, which, if not entirely new, are at least rarely observed. They are due either to direct shock on the skull or to a sudden displacement of air. They are visible when they affect the middle ear, but invisible when they affect the nervous centers, and in the latter case the curves of auditive acuity have the same form as do those of deaf-mutism, which circumstance permits the establishment of a probable cause for the latter. Undoubtedly these observations will be the starting point for the investigation of similar phenomena by other aurists. And perhaps it is not too Utopian to believe that boards of health may some day suppress many noises as are at present only too common in New York city, on the ground that they threaten serious injury to the cerebral nerve centers of a long-suffering populace.

[24] G. G. Henderson in J. Soc. Chem. Ind., 34 (1915), 751.
[25] Sir William Ramsay, *ibid.*, 753.
[26] See Bacon, Science, 40 (1914), 871 *et seq.*

A Vulcanized Solution

ACCORDING to the *Chemical Trades Journal* a German chemist has produced a novel rubber preparation that can be kept in a semi-liquid form, and is useful for cementing rubber surfaces together without any further operation, the result being a very strong joint, as the compound is said to be a true vulcanized rubber. The preparation is made by dissolving one part of crude rubber in about fifteen parts of a light hydrocarbon solvent, then adding a solution of crystallized sulphur in benzine, and submitting the mixture to the action of ultra-violet light from a quartz-tube Cooper-Hewitt mercury-vapor lamp.

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Table of Contents

	PAGE
Modern Methods of Composing Type.—13 illustrations	321
Contact Electrification and the Electric Current.—By Prof. Fernando Sanford	322
Mastication and Food Utilization	323
Large Grained Metals and the Ball Test	323
The World's Yield of Iron and Coal	326
Preserving Caste in English Hospitals	326
Titanium and Its Effects on Steel	327
Making Natural History Popular.—By Warren H. Miller.—7 illustrations	328
The Passing of the Bertillion System of Identification.—By Robert B. Fosdick	330
Curious Cures	331
Family Resemblances	331
Man's Development Illustrated.—By Allen Henry Wright	332
Mortar	332
Diet Under War Conditions	332
Flour Moths and Army Rations.—3 illustrations	333
Films May Help in the Selection of an Occupation	333
Research and Progress in American Manufacture.—By Dr. Raymond F. Bacon	334
Deaf-mutism Produced by Shock	336
A Vulcanized Solution	336

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PAGE
321
By 322
323
323
326
326
327
ber. 328
330
331
331
332
332
333
333
Dr.
334
336
336